Do giant oilfield discoveries make countries poor at taxation?

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Abstract

I exploit the exogenous variation in the timing of giant oil and gas discoveries to estimate the causal impact of natural resources on taxation. It has often been argued that countries that produce natural resources mobilize less non-resource tax revenues than other countries. The timing of giant oil discoveries is arguably exogenous and thus renders them appealing to empirically examine this argument. This allows me to examine the performance of non-resource tax revenue effort before and immediately after discovery as well as the period corresponding to the inflow of revenues from the production. I found that non-resource tax revenues tend to increase for the first two years after a discovery. When I disaggregate non-resource tax revenues into direct and indirect components, I do find that non-resource indirect tax revenues tend to increase in both the pre-production and production periods. Further analysis shows that non-resource tax revenues experience an increase in non-high-income countries while the positive effect on indirect tax revenues in both the pre-production and production is present (absent) only in non-high income (high income) countries. This effect is largely driven by an increase in the consumption of goods and services. The results suggest that the abundance of natural resources might not be a reason why some of these countries mobilize less non-resource tax revenues.

Keywords: Natural Resources, Tax revenue, Giant oilfield discovery
JEL classification codes:E6, H2, Q33, Q38, O13.

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1 Introduction

The Sustainable Development Goals (SDGs) emphasize the need for increased domestic resource mobilization to financing the development challenges. This is particularly important for countries endowed with natural resources because of the unique nature of extractive natural resources which are exhaustible and with volatile revenues. This volatility might be transmitted to the economy in the absence of good fiscal framework leading to macroeconomic instability (Van der Ploeg and Poelhekke, 2010). Also, the climate challenge and energy transition require natural resource producing countries especially those that are reliant on revenues from fossil fuels to pursue economic economic diversification strategies (World Bank, 2022): i.e., reducing the dependence on the resource sector which implies mobilizing more non- resource revenues. However, it has been argued that natural resource producing countries tend to mobilize less domestic revenues (see Figure 1) compared to countries that do not produce natural resources (Collier, 2006; Moore, 1998, 2007). This suggests that natural resources impact the mobilization of non-resource revenues. As argued by Knack (2009), revenues from natural resources can serve as a disincentive to design or maintain efficient tax systems. Furthermore, the reliance on the extractive natural resource sector can lead to exchange rate appreciation thereby crowding out other sectors leading to a low tax base as predicted by theoretical models of Dutch disease (Corden and Neary, 1982; Corden, 1984).

In this paper, I exploit the exogenous variation in the timing of giant oil & gas discoveries[1] to ascertain the causal impact of natural resources on the mobilization of non-resource tax revenues. Specifically, the paper seeks to answer the following questions: Does the discovery of giant oilfields lead to a lower non-resource tax effort? Which component(s) of non-resource tax revenues is/are affected? The features of giant oil & gas discoveries provide a unique source of a macro-relevant news shock (Arezki et al., 2017); There is a lag between discovery and initial production for about

[1] Recent studies that have used this identification strategy (Lei and Michaels, 2014; Harding et al., 2020; Arezki et al., 2017; Perez-Sebastian et al., 2021)

four (4) to six (6) years. This provides news about future output and future inflow of revenues and therefore allows one to directly examine the performance of non-resource revenue mobilization before and immediately after discovery as well as the period corresponding to the inflow of revenues from the production of oil & gas. Also, the timing of giant resource discoveries is arguably exogenous and unpredictable due to the uncertain nature of oil exploration.

I found that giant oil & gas discoveries do not lead to a crowding out of non-resource tax revenues. Non-resource tax revenues tend to increase for the first two years after a discovery. This is mainly due to an increase in non-resource indirect tax revenues. Specifically, non-resource indirect tax revenues increased before and after the actual production following a giant discovery in non-high-income countries while it increased only after actual production starts in high income countries. I also found that the impact on non-resource indirect tax revenues is largely driven by an increase in the tax base (increase in the consumption of goods and services) but not the tax rate.

This paper makes two (2) main contributions to the existing literature. Firstly, I provide evidence of causal effect of the abundance of natural resources on tax effort. The result from existing empirical studies generally indicates a crowding out effect and fraught with endogeneity problems. Bornhorst et al. (2009) investigated if there is evidence of an offset between government revenues from oil & gas activities and domestic revenues in a panel of 30 hydrocarbon producing countries. They found a statistically significant negative relation between oil & gas revenues and domestic revenues. Specifically, they found out that a one percentage point increase in oil & gas revenue lowers domestic revenues by about 0.2 percentage points. Building on the work of the previous authors, Crivelli and Gupta (2014) investigated the impact of resource revenues on different components of non-resource revenues in 35 resource-rich countries. Their results indicate that resource revenues crowd out taxes on goods and services more for the VAT while the impact on corporate and trade taxes is smaller. Thomas and Trevino (2013) also found that non-resource revenue is negatively influenced by higher resource revenues for Sub Saharan Africa. This crowding out effect could be due to the way this issue has been investigated where non-resource revenues (as % of GDP) is normally regressed on resource revenues (as % of GDP). This is problematic because resource revenue to GDP ratio can increase due to an increase in the production of natural resources. Non- resource revenue to GDP ratio can therefore appear to be crowded out due to this increased income thereby biasing the results. Ossowski and Gonzáles (2012) tried to overcome this endogeneity issue by regressing the ratio of non-resource revenue to non-resource GDP on resource revenue to GDP ratio in a sample of 15 Latin American and Caribbean countries and found that revenues from non-renewable resources tend to reduce non-resource revenue performance. However, expressing resource revenue as a ratio of resource GDP takes away the importance of resource revenue in the economy and rather focus on the effective tax rate in the resource sector since the revenues accrued from the sector depends on the fiscal regime. Secondly, I also show that the news of a natural resource discovery could have potential anticipatory effect on tax effort. All the aforementioned existing empirical studies have one thing in common: they assume that the exploitation i.e., the revenue generated from production of natural resources tend to impact domestic resource mobilization thereby overlooking important short run implications.

The remainder of the paper is structured as follows: In section 2, I present the data and the empirical strategy used in the paper. The results are presented and discussed in section 3. I then proceed to analyze the heterogeneity of the effects in section 4. Some additional tests are conducted in section 5 to check the robustness of the results while I present the conclusions in section 6.

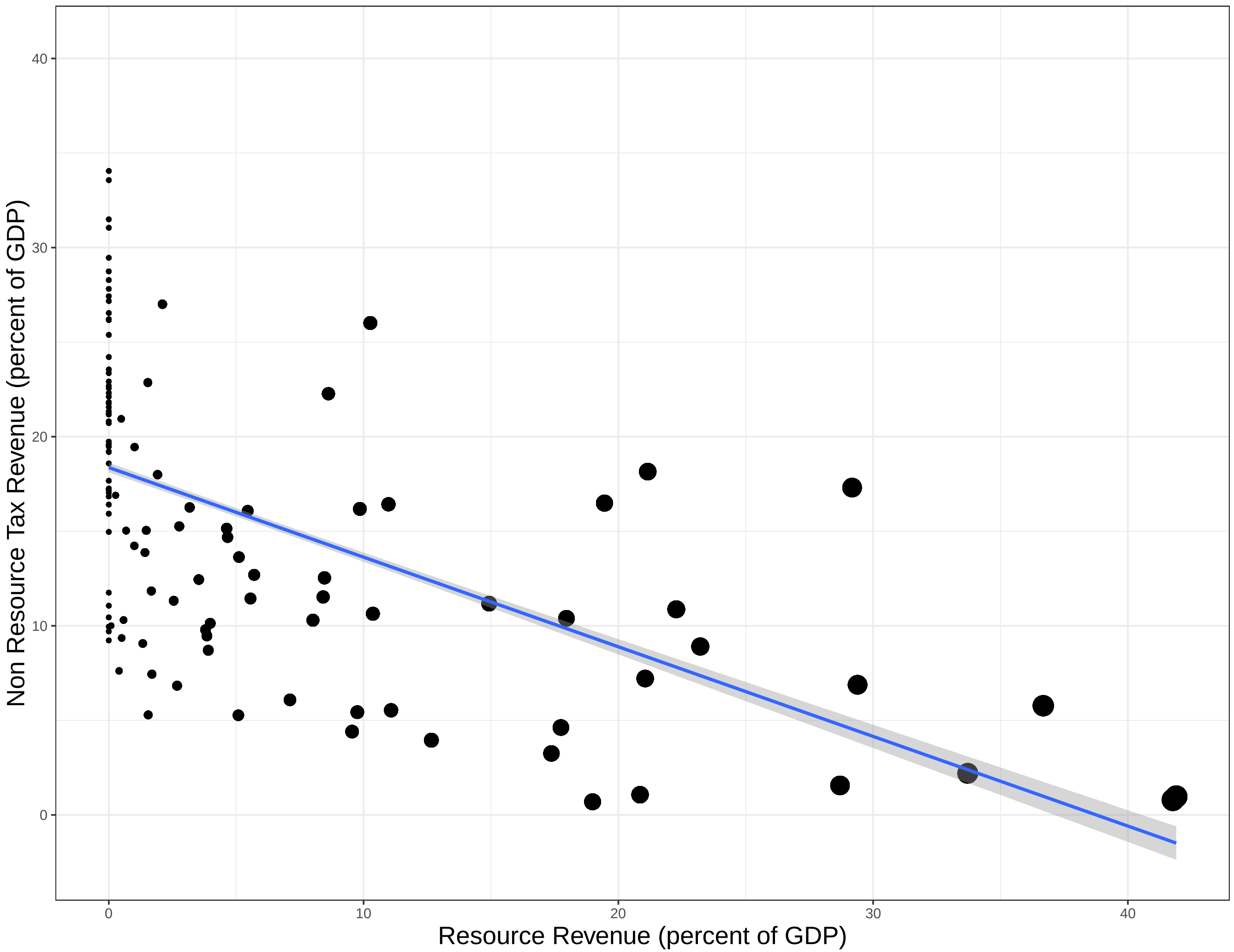


Figure 1: **Average resource Revenues vs Average non-resource taxes(1990-2016)**

Notes: The figure shows scatter plot of the averages of resource revenues and non-resource taxes across different regions. The dots represent each country, and the size of the dots represents the magnitude of average resource revenues. The country regional groupings are based on the classification of the World Bank.

2 Data and Empirical Strategy

2.1 Data

The study made use of two (2) main datasets;

Giant oil and gas discoveries. The first data is on giant oil and gas discoveries for a set of countries. This data comes from Horn (2011) and contains information on the timing, the location, and the estimated ultimately recoverable reserve (URR) of oil and gas (in oil equivalent). A discovery is considered as a giant discovery if it has an estimated URR at least 500 million barrel of oil equivalent (MMBOE).

Giant discoveries were made in 48 countries over the period under consideration in this study. I plot the distribution of the number of giant oilfields discovery over time in Figure 2. One can see there is great variation in the number of discoveries made over time. Figure 3 shows the distribution of the number of discoveries across regions. One can see that there have been significant number of giant oilfields discovered in the various regions.

Non-Resource Tax Revenues Data. The second data is on tax revenues and comes from the International Centre for Tax and Development (ICTD) Government Revenue Dataset (GRD). The ICTD GRD has an improved coverage and makes a consistent distinction between tax and non-tax revenues. This gives it an advantage over other sources of government revenues such as the IMF and the World Bank. The tax revenues are decomposed into resource and non-resource tax revenues. This is very important for my study as I want to adequately capture the impact of natural resources on non-resource tax revenues and its various components. In this study, non-resource tax revenue is defined as tax revenues excluding social contributions and resource tax revenues.

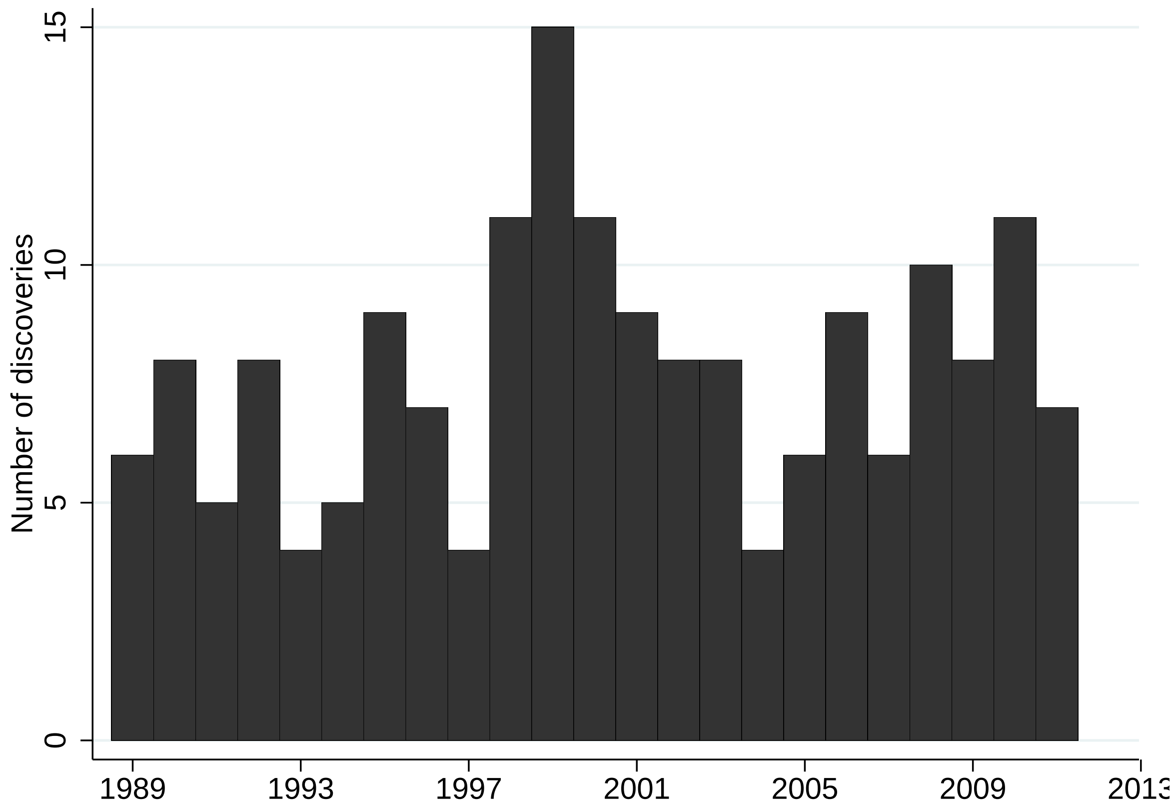


Figure 2: **Number of discoveries across time (1989-2012)**

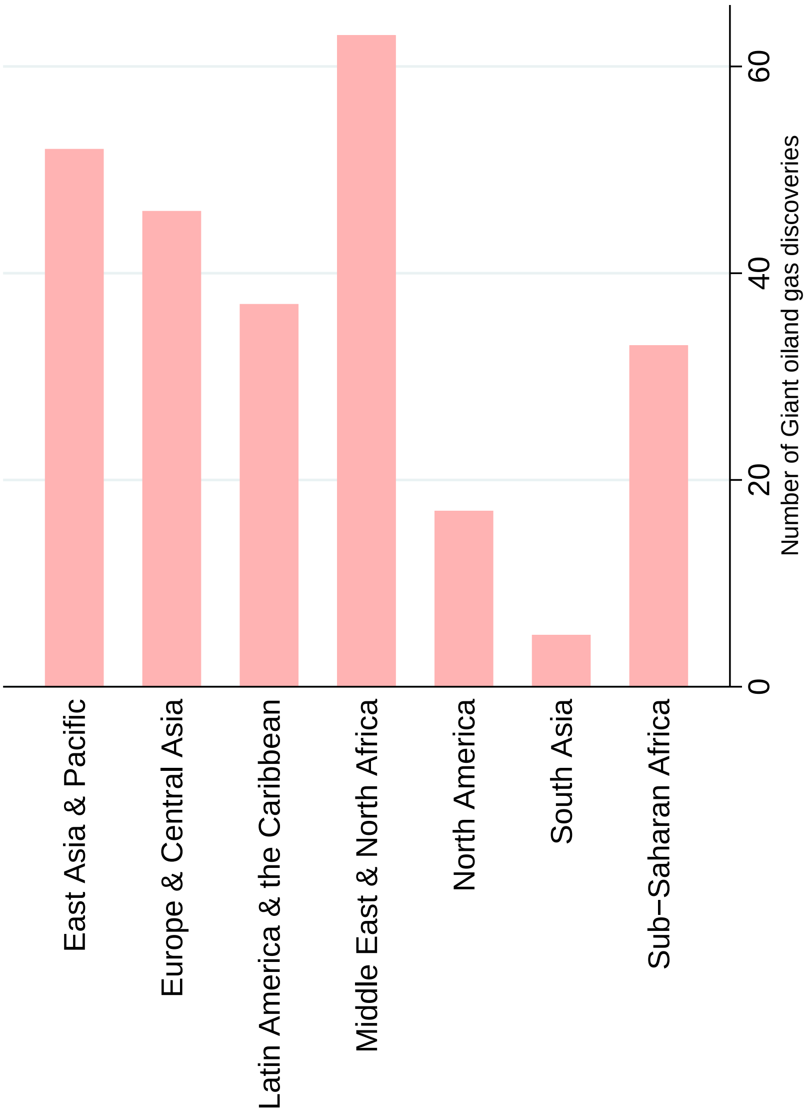


Figure 3: **Number of discoveries over regions (1989-2012)**

Control Variables. The control variables used in the study were selected in line with the tax effort literature. These includes population growth and real GDP per capita to account for the level of development of each country. It is expected that a higher per capita income and a rapid population growth to be associated with higher tax collection. I also control for the structure of the economy by including the agricultural share of value added in GDP. It is expected that less tax revenues will be mobilized if most of the economic activity is concentrated in the agricultural sector which is largely informal and difficult to tax. Data on the control variables were sourced from the World Bank Development Indicators. Summary statistics and sources of all the variables are shown in Table 1.

Table 1: **Summary Statistics**

Variable	Nos of Countries	Observations	Min	Median	Max	Source
Non-Resource Tax Revenues(% of GDP)	184	3878	0.1	15.4	53.9	ICTD-GRD
Direct Tax Revenues(% of GDP)	178	3573	0	4.8	25.2	ICTD-GRD
Indirect Tax Revenues(% of GDP)	178	3634	0	10.1	43	ICTD-GRD
Tax Revenues from on Goods and Services(% of GDP)	183	3627	0	6.7	34.9	ICTD-GRD
Tax Revenues from International Trade (% of GDP)	184	3666	-1.6	1.6	36.1	ICTD-GRD
Other indirect tax revenues (% of GDP)	182	3490	-2.1	0.1	7.9	ICTD-GRD
Real GDP per capita	185	4189	115.8	3545.4	111968.4	WDI
Population Growth	188	4482	-6.2	1.5	16.3	WDI
Agriculture Value Added	183	3949	0	11.1	94	WDI

Data Sources: ICTD GRD: International Center for Tax and Development Government Revenue Dataset, WDI: World Bank Development Indicators

2.2 Identification Strategy

The identification strategy used in this paper is based on the exogeneity of the timing of giant oil discoveries. Thus, the timing of these discoveries is independent of country specific characteristics. In this section, I follow others in the literature to argue that this is truly the case.

Upstream petroleum exploitation can be broken down into four (4) main stages: Exploration & Appraisal, Development, Production and Decommissioning. Exploration basically means to search for oil. Host governments can explore for oil on their own through a state agency or grant licenses[2] to International Oil Companies(IOCs). Various factors influence the decision to undertake an exploration activity such as the geology, institutions, political and economic stability among others. In addition, exploration of oil and gas (and other extractive natural resources) is affected by technological innovation and by the relative knowledge of geological features of a particular field (such as the structure of the oil field, the depth, location, etc.). This therefore makes exploration an uncertain activity. Only 2% of the total number of exploratory wells lead to a giant discovery and the relationship between the intensity of exploration drilling activity and making a giant discovery is rather weak (Toews and Vezina, 2016). Once some fields have been identified as potentially containing viable oil/gas resources, they are examined in more details to establish their commercial viability. This is known as appraisal. Exploration activities can last for 1 to 5 years.

The development phase sets in when a commercial discovery is made in the previous stage otherwise the operations are terminated. The development phase involves putting in the necessary infrastructure after a commercial discovery have been made to bring out the oil. Production occurs when the oil and gas is extracted for distribution or processing. The time lag from discovery to production can take on average 4 to 6 years. Production activities can last for at least 20 years on average. Finally, once it is no longer economic feasible to produce from the field, the site is returned to its original state as close as possible. This is known as decommissioning.

[2]These licenses can be granted through direct negotiations or through an open & competitive bidding process.

From the foregoing, it can be argued that the characteristic(s) of a country is likely to determine whether an exploration activity takes place or not but less likely to determine whether a giant discovery will be made. It is difficult to predict the timing of such a discovery from a country's (and companies') point of view and thus can be viewed as an unanticipated news shock (see Arezki et al., 2017). One might argue that oil discoveries are somewhat predictable because some countries have larger oil endowments or because they had discoveries in the past. This is also likely to work in the opposite direction: past discoveries can increase the cost of discovery thereby rendering future discoveries less likely. Even in both cases, the exact timing of the giant oil discovery is less likely to be predictable. However, I control for past discoveries in all the empirical specifications.

2.3 Empirical Model

To examine the impact of giant oil and gas discoveries on domestic revenue mobilization from 1989 to 2012, the following econometric model is specified;

$$Y_{it} = \alpha_i + \theta_t + \sum_{j=-2}^{10} \beta_j Discovery_{it-j} + \gamma_1 pastdiscovery_{it} + \delta X_{it_{-1}} + \epsilon_{it} \tag{1}$$

where Y_{it} is a measure of tax revenues from the non-resource sector to GDP ratio in country i at time t, α_i is a country dummy to account for country fixed effects, θ_t is a year dummy that accounts for time varying common shocks, $Discovery_{it}$ is a dummy variable equal to 1 if a country i makes at least one giant oil and gas discovery at time t. As discussed earlier, there is a significant lag between discovery and production which suggest that the effect might not be immediate but may take time to materialize and last for a period. I exploit these dynamics by including two (2) leads and ten (10) lags of the discovery variable. This implies that β and Discovery are a vector of 13 components each. pastdiscovery is the number of years with past discoveries and X_{it} is a vector of control variables. To limit endogeneity issues, the control variables enter the regression with a lag.

3 Empirical Results

3.1 Effect of oil discovery on Non-Resource Tax Revenues

In Figure 4, I present the empirical estimates of equation (1) with non-resource tax revenues as the dependent variable. The first thing to notice is that the coefficients of the first two leads of the discovery variable are not statistically different from zero. This suggest that there is no anticipatory effect i.e., there is no statistically significant effect of giant oilfields discovery on non-resource revenue mobilization prior to the time of discovery.

Secondly, non-resource tax revenues tend to increase up to the second year after a discovery and experienced a decline from the third year. The positive response for the first two years after discovery is statistically different from zero. However, non-resource tax revenues tend to be relatively stable and statistically not different from zero when the production of oil sets in (from the fifth year).

To investigate the general pattern of what happens in the discovery and the production periods as opposed to what happened in a particular point in time, I estimate a version of model (1);

$$Y_{it} = \alpha_i + \theta_t + \beta_1 Preproduction_{it} + \beta_2 Production_{it} + \beta_3 pastdiscovery_{it} + \delta X_{it_{-1}} + \epsilon_{it} \tag{2}$$

Where Preproduction is a five-year period (between t and t-4) to capture the average period, it takes to start production. Preproduction is therefore the period from discovery until the onset of production. Production is also a five-year period (from t-5 to t-9) that captures production period.

The estimates are reported in Table 2. Without controlling for the number of discoveries made in the past, the structure and level of development, non-resource tax revenues tend to increase on average during the preproduction period years and decrease during the production years. These effects are however not statistically different from zero. The results remain unchanged when I control for the number of discoveries made in the past. When I control for the structure and level of development of the economy, the negative response during the production turns to positive although this is still not statistically significant. Therefore, in the benchmark case I do not find a statistically significant effect.

The results as shown above contradicts most of the results from the existing literature which normally points to a crowding out effect. As explained earlier, this crowding out effect could be due to the methodology employed in these studies. However, the data used in the present study comes from the ICTD-GRD which is different from the data used in the existing studies. Could the contradiction in the result be due to the difference in the data used and not the methodological difference? To show that this is not likely to be the case, I replicate the result of the existing studies with the data from ICTD-GRD. The results are presented in Table A.1 in the Appendix. As can be seen, the results largely point out to a crowding out effect. Specifically, an additional percentage point increase in resource revenues (as % of GDP) decreases non-resource tax revenues (as % of GDP) and indirect non-resource revenues by 0.13 and 0.12 percentage points respectively. This is statistically significant. These estimates compare (although lower than) relatively with those found in the existing literature. For example, while Bornhorst et al. (2009) found an offset of 0.2 percentage points, Crivelli and Gupta (2014) found an offset of 0.3 percentage points.

The foregoing therefore suggests that the differences in data sources is likely not a reason for the differences in the result obtained.

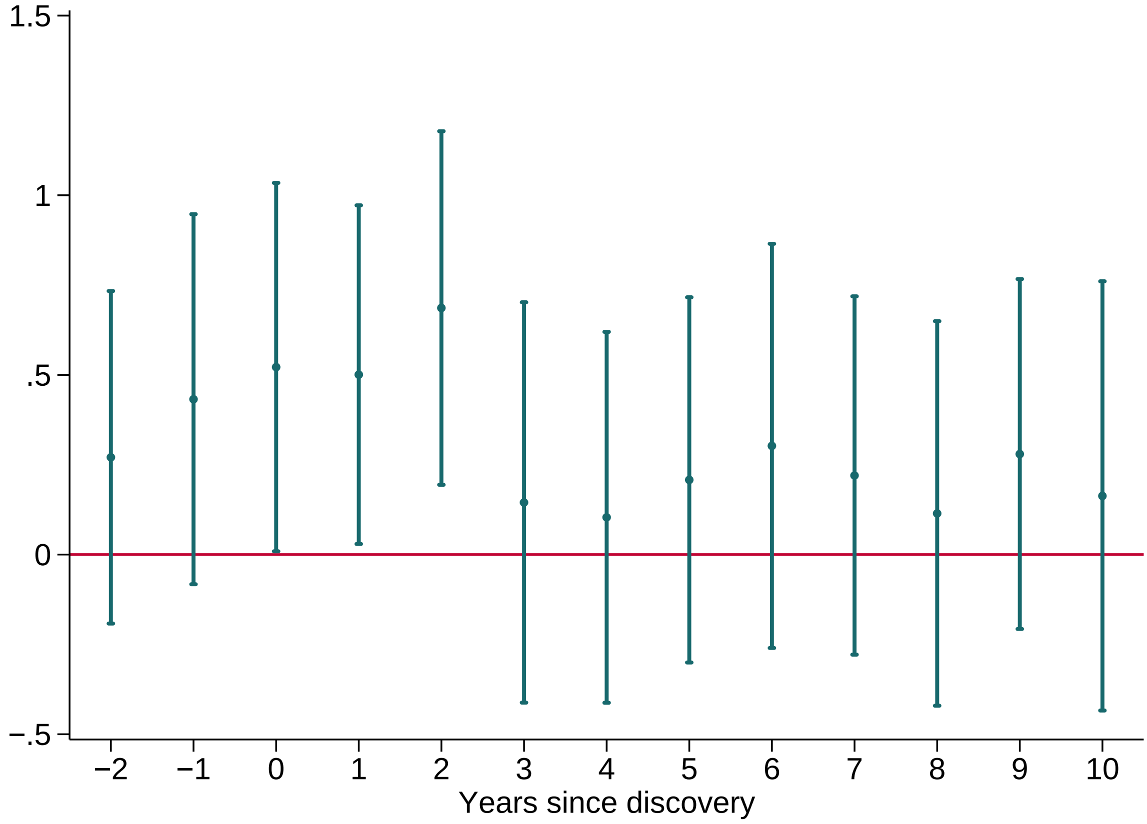


Figure 4: **Intertemporal effect of oil and gas discoveries on non-resource taxes**

Notes: The figure shows the effect of giant oil discoveries on non-resource taxes over time by including 2 leads and 10 lags (from t-2 to t+10) of the discovery variable. The dots show the point estimates, and the bars indicate 95% confidence intervals. Standard errors in the regressions are clustered and robust. The regression includes the number of years with past discovery, other control variables as well as country and year fixed effects.

Table 2: Effect of oil and gas discoveries on non-resource tax revenues

	(1)	(2)	(3)
preproduction	0.246	0.224	0.336
	(0.351)	(0.373)	(0.370)
production	-0.195	-0.219	0.102
	(0.350)	(0.371)	(0.379)
pastdiscovery		0.026	0.072
		(0.115)	(0.109)
Constant	15.810***	15.808***	18.157***
	(0.396)	(0.394)	(0.812)
Observations	3,878	3,878	3,416
R-squared	0.065	0.065	0.140
Number of Countries	184	184	173
Control Variables	No	No	Yes
Within R-squared	0.0647	0.0647	0.140

Notes: The dependent variable are non-resource tax revenues (% of GDP). The 2nd column controls for the number of discoveries made in the past while the 3rd column controls for the level of development and the structure of the economy in addition to the number of discoveries made in the past. Robust Standard errors, clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%. All regressions include country and year fixed effects.

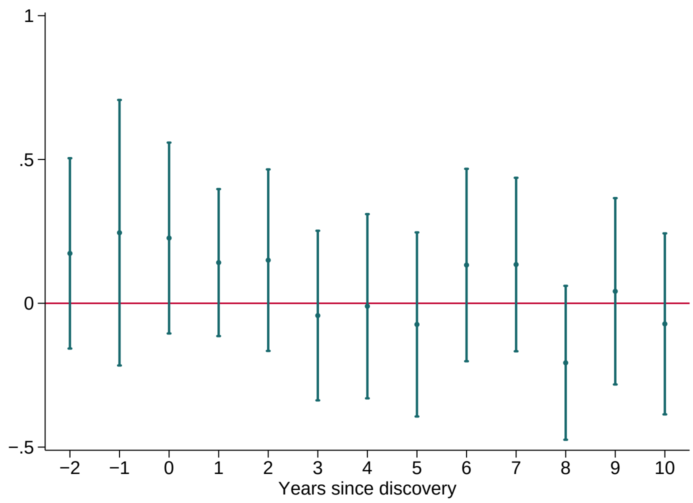
3.2 Effect of oil discovery on Non-Resource Direct and indirect Tax Revenues

It is widely known that the oil & gas sector is an enclave and capital-intensive sector. This implies that relatively low number of jobs will be created directly per unit of capital invested. On the other hand, an oil discovery and its subsequent exploitation can lead to the import of materials and capital goods that can increase custom duties or spillover effects on local activity that can increase VAT. This suggests that different tax revenues might respond differently to a giant oil discovery. In this section I decompose non-resource tax revenues into direct and indirect components. The ICTD-GRD data allows for such decomposition. I first looked at the behavior of non-resource direct and indirect tax revenues over time by estimating model (1). The results are shown in Figure 5. For direct non-resource tax revenues, the estimates are not statistically different from zero. The indirect component of non-resource tax revenues tends to increase after a discovery and remains positive for ten (10) years.

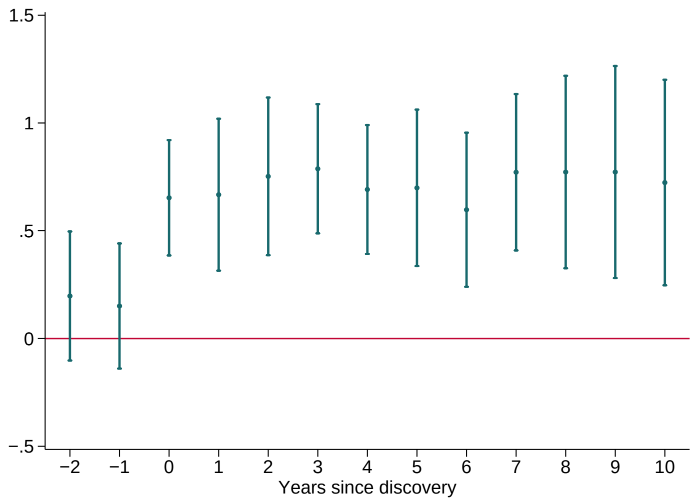
In addition, I examined the behavior of these two (2) variables during the preproduction and production periods by estimating equation (2). The results are presented in Table 3. In both the preproduction and production periods, the direct component of non-resources tax revenues (columns 1 to 3) responds positively and negatively respectively. These effects are not statistically significant. The indirect component of non-resource revenues, on the other hand tends to increase during the preproduction period (see columns 4 to 6) in all three specifications. These effects are statistically different from zero. In the absence of control variables, indirect non-resource revenues respond positively although not significant. This positive effect however becomes significant when I condition on the control variables (column 6). During the preproduction and production periods, indirect non-resource tax revenues increase by 0.52 and 0.48 percentage points respectively conditional on the structure and the level development of the economy. Taken, together the results suggest that giant oil and gas discoveries does not have a significant on total non-resource tax revenues but a significant positive effect on indirect non-resource tax revenues.

I further investigated the dynamics of the components of indirect taxes (tax revenues from goods & services, trade and other indirect tax revenues) to ascertain which of these components is driving the effect. Comparing the three (3) charts in Figure 6 suggests that the effect on indirect taxes is mainly driven by taxes on goods & services.

Moreover, to further understand the results, I divide my sample into two: if the country is high income by the World Bank and the non-high-income countries. The main motivation for this division is that the same size of a giant oil discovery will have differential effect on a developed economy like USA compared to a developing economy like Ghana. The results are presented in Table (4). The general pattern of the results continues to hold in the case of and direct non-resource tax revenues for both group of countries. However, the effect in the preproduction era in the case of non-resource tax revenues is positive and different from zero for the non-high-income countries but not for the high-income countries. Also, indirect tax revenues tend to increase in both the preproduction and production era in only the non-high-income countries. The results therefore suggest that the effect of giant oil discoveries is significant on non-high-income countries as compared to high income countries.



(a) Direct Tax Revenues



(b) Indirect Tax Revenues

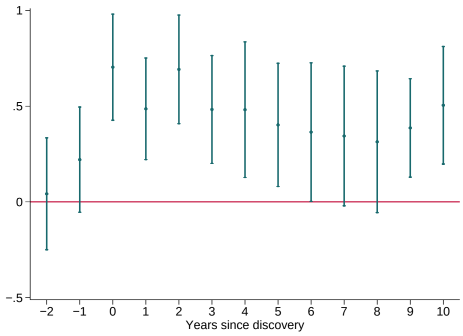
Figure 5: **Intertemporal effect of oil and gas discoveries on non-resource direct and indirect tax revenues**

Notes: The figure shows the effect of giant oil discoveries on non-resource direct(panel a) and indirect tax(panel b) over time by including 2 leads and 10 lags (from t-2 to t+10) of the discovery variable. The dots show the point estimates, and the bars indicate 95% confidence intervals. Standard errors in the regressions are clustered and robust. The regression includes the number of years with past discovery, other control variables as well as country and year fixed effects

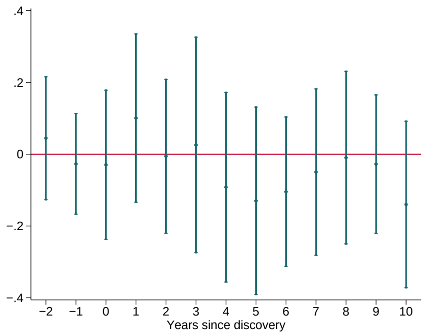
Table 3: Effect of oil and gas discoveries on direct and indirect non-resource tax revenues

	Non-resource direct tax revenues			Non-resource indirect tax revenues		
	(1)	(2)	(3)	(4)	(5)	(6)
preproduction	0.049	-0.001	0.033	0.401**	0.443**	0.515**
	(0.221)	(0.230)	(0.226)	(0.201)	(0.220)	(0.213)
production	-0.082	-0.133	-0.097	0.103	0.144	0.419*
	(0.183)	(0.194)	(0.209)	(0.263)	(0.272)	(0.252)
pastdiscovery		0.051	0.068		-0.050	-0.010
		(0.063)	(0.057)		(0.080)	(0.075)
Constant	5.870***	5.870***	6.727***	9.973***	9.977***	11.729***
	(0.216)	(0.216)	(0.532)	(0.265)	(0.264)	(0.500)
Observations	3,573	3,573	3,157	3,634	3,634	3,208
R-squared	0.043	0.044	0.076	0.048	0.048	0.113
Number of Countries	178	178	168	178	178	168
Control Variables	No	No	Yes	No	No	Yes
Within R-squared	0.0433	0.0441	0.0762	0.0477	0.0482	0.113

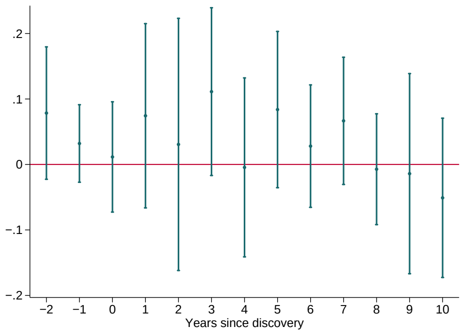
Notes: The dependent variables are non-resource direct taxes (% of GDP) columns 1 to 3 and non resource indirect taxes(% of GDP) columns 4 to 6.The 3rd and 6th columns controls for the level of development and the structure of the economy. Robust Standard errors, clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%. pastdiscovery is defined as the number of years with past discovery. All regressions include country and year fixed effects.



(a) **Tax on goods & services**



(b) **Trade taxes**



(c) **Other indirect Taxes**

Figure 6: **Intertemporal effect of oil and gas discoveries on components of indirect taxes**

Notes: The figure shows the effect of giant oil discoveries on the components of non-resource indirect taxes over time by including 2 leads and 10 lags (from t-2 to t+10) of the discovery variable. The dots show the point estimates, and the bars indicate 95% confidence intervals. Standard errors in the regressions are clustered and robust. The regression includes the number of years with past discovery, other control variables as well as country and year fixed effects

Table 4: **High Income vs Non-High Income countries**

	High Income Countries			Non-High Income Countries		
	nrtax	direct	indirect	nrtax	direct	indirect
preproduction	-1.039	-0.064	0.043	0.698***	0.024	0.718***
	(1.039)	(0.490)	(0.440)	(0.245)	(0.200)	(0.250)
production	-0.671	0.189	-0.254	0.242	-0.148	0.640**
	(0.624)	(0.403)	(0.317)	(0.412)	(0.226)	(0.293)
pastdiscovery	-0.054	-0.088	-0.045	0.101	0.126**	-0.003
	(0.158)	(0.086)	(0.155)	(0.121)	(0.062)	(0.087)
Constant	22.974***	11.775***	11.018***	15.146***	4.942***	10.916***
	(1.546)	(1.226)	(0.983)	(0.964)	(0.596)	(0.774)
Observations	882	850	869	2,332	2,132	2,154
R-squared	0.124	0.149	0.070	0.158	0.096	0.123
Number of Countries	51	49	49	119	116	116
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents the estimates of equation (2) for high income income countries and non-high income income countries. nrtax is non-resource tax revenues; direct is non-resource direct tax revenues and indirect is non-resource indirect revenues. Robust Standard errors, clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%. All regressions include country and year fixed effects.

3.3 Mechanisms

What could possibly account for the positive effect on revenues generated from taxing the consumption goods and services? The tax rate or the tax base? In order to answer this question, I compute the response of consumption (the tax base) and the consumption tax rate to a giant oil discovery shock by estimating model (2). The consumption tax is computed as;

$$\begin{aligned} Consumption \quad tax \quad rate &= \frac{tax \quad revenue \quad on \quad goods \quad \& \quad services}{Consumption} \\ &= \frac{Consumption \quad tax \quad rate * Consumption}{Consumption} \end{aligned} \tag{3}$$

The results are presented in Table 5. As can be seen the effect on the tax rate in both the preproduction and production periods are not different from zero. Consumption (the tax base for goods & services) on the other hand tend to increase in both the preproduction and production periods. The result suggests the positive effect of oil discovery on tax revenues from goods and services is largely due to an increase in the tax base (consumption) but not a change in tax policy (tax rate).

There are several potential ways through which an oil discovery could widen indirect tax base in both the preproduction and production periods. In the pre-production period (i.e the period between discovery and production), the necessary infrastructure is put in place the extract the oil. The economy can potentially benefit from imports of materials and capital goods that increase customs duties and VAT revenues. Also, the government could use the oil in the ground as collateral to borrow to smooth consumption. Furthermore, due to demand shocks at the local level in particular, goods and services can be demanded locally due to backward linkages leading to agglomeration effects and potentially increasing the VAT base (Aragón et al., 2015). In a recent study, Cavalcanti et al. (2019) found a positive spillover effects of oil discoveries on the local communities in Brazil due to a higher local demand for non-tradable services.

Table 5: **Effect of oil and gas discoveries on consumption and average tax rate**

	Tax rate	Consumption
preproduction	0.014	0.301***
	(0.06)	(0.104)
production	0.151	0.290***
	(0.157)	(0.107)
pastdiscovery	-0.037	0.106***
	(0.038)	(0.026)
Constant	0.001	23.432***
	(0.001)	(0.124)
Observations	3208	3,208
R-squared	0.008	0.404
Number of Countries	168	168

Notes: The dependent variables are consumption tax rate (as defined in equation (3)) and consumption of goods and services. pastdiscovery is defined as the number of years with past discovery. All regressions include country and year fixed effects. Robust Standard errors, clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.

4 Heterogeneous Analysis

I exploit several heterogeneities by interacting different variables with the discovery dummy. I interact the 5th and l0th lags with pre-production and production periods respectively to limit endogeneity issues. The results[3] are reported in Table 6.

I first examined whether the effect depends on the degree of financial openness. Countries with high degree of financial openness can use the oil (in the ground) as collateral to borrow from international capital market. To measure the degree of financial openness (FD), I used the IMF financial development index (Svirydzenka, 2016) which is a broad-based measure that considers the depth, access, and efficiency of financial institutions. The more financially opened a country is, the higher the value of the index. The result suggests that the effect of oil discovery on indirect tax revenues in the preproduction era is higher in countries that are less developed financially.

The resource curse literature has emphasized the role of political institutions in influencing economic development. It could therefore be the case that the quality of institutions can affect the relationship between oilfield discovery and the non-resource tax effort. I test this using corruption risk score from the International Country Risk Guide (ICRG) which is an assessment of corruption within the political system. This corruption risk index has a minimum score of zero and maximum score of six. A higher score indicates a lower corruption risk. I standardized the score to ease interpretation. A similar result is found in this case as well. While the result suggests that non-resource indirect tax revenues increases more in countries with high corruption risk, it could also be seen as a reinforcement of the previous result that the effect in the preproduction is as many low income countries tend to have relatively poor political institutions .

Finally, I examined whether the effect depends on the level of democracy which is measured via the standard polity2 variable from the Polity IV project. The result

[3] I only report the estimates of non-resource indirect tax revenues since the coefficients of preproduction and production variables are still not different from zero for the others. They are however available upon request.

suggests the effect does not depend on the level of democracy.

Table 6: Heterogeneous Analysis

	(1)	(2)	(3)
preproduction	0.456**	0.579***	0.540**
	(0.212)	(0.200)	(0.235)
production	0.395*	0.497*	0.574*
	(0.234)	(0.289)	(0.296)
preproduction*FD_{t-5}	-0.362*		
	(0.208)		
production*FD_{t-10}	-0.158		
	(0.194)		
preproduction*$corruption_{t-5}$		0.317*	
		(0.167)	
production*$corruption_{t-10}$		-0.052	
		(0.119)	
preproduction*$democracy_{t-5}$			-0.219
			(0.197)
production*$democracy_{t-10}$			-0.157
			(0.167)
Constant	12.337***	11.363***	12.193***
	(0.467)	(0.574)	(0.572)
Observations	3,057	1,887	1,999
R-squared	0.126	0.122	0.126
Number of Countries	161	120	109
Control Variables	Yes	Yes	Yes

Notes: The table shows the heterogeneous effect of giant oil discoveries on the components of non-resource indirect tax revenues. kaopen is an index of financial openness, corruption is corruption risk score from the International Country Risk Guide (ICRG) and democracy is proxied with the polity2 variable taken from the Polity IV project.

5 Robustness Tests

The results so far suggest, the discovery of giant oil & gas discovery does not have a statistically significant effects on aggregate non-resource tax revenues. In this section, I test the robustness of this result.

Firstly, there are several variables that can potentially affect tax effort that was not controlled for in the benchmark model mainly due to missing data for some countries. I include some of these variables as additional control in the benchmark model. The results are shown in TableA.2. As can be seen the number of observations and countries reduce drastically. However, the main results still hold.

Secondly, I make use of different measures for giant oilfield discoveries. The results are reported in Table A.3. I first make test if the result is sensitive to the location of the discovery. Discoveries can be made offshore (which is the typical case) or onshore. The results remain like the baseline case. Also, I exclude from the sample discoveries that were made in the past three (3) years and discoveries that were made subsequently to each other. This enables me to test if the potential endogeneity of discoveries that were made after the initial ones could affect the results. As can be seen in columns 3 and 4, the baseline result continues to hold in this case as well.

Finally, I make use of five (5) alternative measures of the dependent variable: the growth rates of non-resource tax revenues, non-resource tax revenue per capita ,ratio of non-resource tax revenues from income, profits and capital gains to total non-resource tax revenues, non-resource tax revenue to non-resource GDP ratio [4] and non-resource tax revenues to total tax revenues to examine if the baseline results are sensitive to alternative measures of the dependent variables. The third definition follows from Besley and Persson (2014) where they consider fiscal capacity is considered the ability of the fiscal system to raise revenues from broad based taxes. As can be seen in A.4 the results are very similar to the main results.

[4] Non -resource GDP by subtracting mining, quarrying and electricity, gas and water supply from the total GDP measure from the (United Nations, 2013).

6 Conclusions

In this paper, I investigated the effect of natural resources on domestic revenue mobilization by exploiting the exogenous variation in the timing of giant oilfield discovery. This approach allowed me to deal with the endogeneity of natural resources as the timing of the discovery of giant oilfields is arguably exogenous. Also, this approach allowed me to directly examine the performance of non-resource revenue mobilization before and immediately after discovery as well as the period corresponding to the inflow of revenues from the production of oil & gas. I do find that non-resource tax revenues tend to increase in the first two years following a giant discovery. On average, non-resource tax revenues experienced an increase in both the pre-production and production periods although not statistically significant. This result is robust to alternative measures of giant oil discoveries. However, when I disaggregate non-resource tax revenues into direct and indirect components, I do find that indirect tax revenues tend to increase in both the preproduction and the production era. Further analysis reveals that the positive effect on indirect non-resource tax revenues is due to an increase in the tax revenue mobilized from the consumption from goods & services. This is mainly driven by an increase in consumption of goods & services. The empirical results for high income and non-high-income countries are mixed. While I do not find any significant effect on non-resource tax revenues for high income countries, I do find that non-resource tax revenues tend to increase in non-high-income countries in the preproduction era. This is effect is different from zero. Also, non-resource indirect tax revenues experienced an increase in both the preproduction and production periods in only non-high-income countries. Taken together the result suggest that the crowding effect found in the literature could be due to the way the issue has been investigated as evidenced in the replication of the existing studies. The results therefore suggest that the abundance of natural resources may not be a reason why some of these countries mobilize less tax revenues.

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Appendix A: Additional Tables

Table A.1: Replication of what is normally done in the literature

	nrtax	direct	indirect
resource revenue	-0.128***	-0.031	-0.119***
	(0.048)	(0.027)	(0.044)
logdppercapita	-0.340	-0.576*	0.122
	(0.346)	(0.298)	(0.210)
nropeness	0.000**	0.000*	-0.000
	(0.000)	(0.000)	(0.000)
agriculture	-0.089**	-0.041	-0.060
	(0.043)	(0.030)	(0.039)
corruption	0.473**	0.238*	0.145
	(0.206)	(0.143)	(0.134)
Constant	16.388***	4.741***	11.843***
	(2.221)	(1.599)	(1.325)
Observations	1,076	1,025	1,035
R-squared	0.115	0.155	0.095
Number of Countries	76	72	72
Control Variables	Yes	Yes	Yes

Notes: The table presents the regression of non-resource tax revenues on resource revenues from 1989 to 2012. nrtax is non-resource tax revenues; direct is non-resource direct tax revenues and indirect is non-resource indirect revenues. logdppercapita is the log of real GDP per capita; nropeness is the non-resource exports plus non-resource imports to GDP ratio; Agriculture is the agriculture value added (% of GDP) and corruption is a 6-point corruption risk score from the International Country Risk Guide (ICRG). All regressions include country and year fixed effects. Robust Standard errors clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.

Table A.2: Effect of giant oil discoveries on non resource tax revenues: Additional control variables

	nrtax	direct	indirect
preproduction	0.444	0.154	0.553**
	(0.412)	(0.257)	(0.226)
production	0.290	-0.046	0.568*
	(0.400)	(0.235)	(0.309)
pastdiscovery	0.077	0.056	-0.063
	(0.148)	(0.088)	(0.143)
Constant	16.944***	6.647***	10.614***
	(1.340)	(0.797)	(0.943)
Observations	1,955	1,813	1,855
R-squared	0.174	0.125	0.098
Number of Countries	106	103	103
Control Variables	Yes	Yes	Yes
Within R-squared	0.174	0.125	0.0977

Notes: The table presents the regression of non-resource tax revenues on resource revenues from 1989 to 2012 with additional control variables. The additional control variables are trade balance, level of democracy,corruption and financial openness. nrtax is non-resource tax revenues; direct is non-resource direct tax revenues and indirect is non-resource indirect revenues. All regressions include country and year fixed effects. Robust Standard errors clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.

Table A.3: Robustness Tests using alternative measures of giant oilfield discoveries

	Onshore discoveries	Offshore discoveries	No discovery in the past 3 years	Non-sequential discoveries
preproduction	0.398	0.458	0.452	0.480
	(0.322)	(0.369)	(0.620)	(0.431)
production	-0.024	0.054	0.013	0.036
	(0.337)	(0.376)	(0.401)	(0.360)
pastdiscovery	0.056	-0.058	0.018	-0.029
	(0.171)	(0.202)	(0.723)	(0.307)
Constant	19.159***	19.213***	19.181***	19.211***
	(0.830)	(0.822)	(0.850)	(0.833)
Observations	4,028	4,028	4,028	4,028
R-squared	0.132	0.132	0.132	0.132
Number of Countries	174	174	174	174
Control Variables	Yes	Yes	Yes	Yes

Notes: The table shows the effect of different measures of giant oil discoveries on the components of non-resource tax revenues (columns 1 to 4). All the specifications control for the number of years with past discovery, the level of development and the structure of the economy. All regressions include country and year fixed effects. Robust Standard errors clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.

Table A.4: Robustness Tests using alternative measures of the dependent variable

	(1)	(2)	(3)	(4)	(5)
preproduction	0.054	-0.280	-0.017	0.002	-0.020
	(13.985)	(1.340)	(0.013)	(0.019)	(0.016)
production	-0.895	0.735	-0.010	-0.019	-0.016
	(15.677)	(1.352)	(0.014)	(0.030)	(0.010)
pastdiscovery	1.220	-0.072	0.008**	-0.017	0.005
	(9.829)	(0.269)	(0.003)	(0.017)	(0.004)
Constant	104.636	3.449**	0.385***	0.187	0.971***
	(64.723)	(1.486)	(0.018)	(0.146)	(0.012)
Observations	4,028	3,940	3,358	3,595	3,958
R-squared	0.008	0.013	0.080	0.008	0.031
Number of Countries	174	174	167	157	172
Control Variables	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.00762	0.0133	0.0802	0.00836	0.0310

Notes: The table shows the effect of giant oil and gas discoveries on different measures of the dependent variable. Non-resource tax revenues per capita in column 1, growth rate of non-resource tax revenues in column 2, ratio of non-resource tax revenues from income, profits and capital gains to total non-resource tax revenues in column 3, non-resource tax revenue to non-resource GDP ratio in column 4 and tax structure (non-resource tax revenues to total tax revenues). All the specifications control for the number of years with past discovery, the level of development and the structure of the economy. All regressions include country and year fixed effects. Robust Standard errors clustered at the country level, are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.