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Government responses to oilfield discoveries: Impact of resource wealth on non-resource tax revenues

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ABSTRACT

It has often been argued that countries that produce natural resources mobilize less non-resource tax revenues than other countries. In this paper, we exploit the exogenous variation in the timing of giant oilfield discoveries to estimate the causal impact of natural resources on taxation. The timing of giant oilfield discoveries is arguably exogenous and thus renders them appealing to empirically examine this argument. This allows us 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. We find that non-resource tax revenues tend to increase in the period following the discovery before the onset of production and after production commences. This effect is due to an increase in non-resource indirect tax revenues. Further analysis shows that both the total and indirect non-resource tax revenues, experience an increase in only low- -middle income countries, and largely driven by an increase in the consumption of goods and services.

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 change challenge and energy transition require countries that are reliant on revenues from the exploitation of fossil fuels, to pursue 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 non-resource tax revenues (see Fig. 1) compared to countries that do not produce natural resources (Moore, 1998, 2007; Collier, 2006). As argued by Besley and Persson (2013, 2014), revenues from natural resources can serve as a disincentive to design or maintain efficient tax systems. Specifically, the discovery of a natural resource e.g. oil can reduce the incentive to invest in fiscal capacity due to the anticipation of future revenue inflows (Besley and Persson, 2013). Furthermore, the reliance on the natural resource sector can lead to exchange rate appreciation thereby crowding out other sectors as predicted by theoretical models of Dutch disease (Corden and Neary, 1982; Corden, 1984). This could potentially erode the non-resource tax base resulting in lower tax revenues for a given tax rate.

In this paper, we exploit the exogenous variation in the timing of giant oilfields discoveries to ascertain the causal impact of natural resources on the mobilization of non-resource tax revenues.[1] Specifically, the paper seeks to answer the following questions: Does the discovery of giant oilfields lead to a lower non-resource tax revenues? Which components of non-resource tax revenues are affected? The features of giant oilfields discoveries provide a unique source of a macro-relevant news shock (Arezki et al., 2017). This is because there is a lag between discovery and initial production for about four to six years. This provides news about future output and future inflow of revenues and therefore allows us 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 petroleum. Also, the timing of giant resource discoveries is arguably exogenous and unpredictable due to the uncertain nature of oil exploration.

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[1] We use the term oilfields discoveries to indicate both the discovery of oil and gas fields. Recent studies that have used this identification strategy includes Lei and Michaels (2014), Arezki et al. (2017), Harding et al. (2020) and Perez-Sebastian et al. (2021) to study the impact of natural resources on internal armed conflicts, real exchange rate appreciation, macroeconomic performance and protectionism respectively.

[2] The main source of tax revenue data used by researchers is the IMF Government Finance Statistics (GFS). The GFS has less coverage for developing countries. A detailed description of the ICTD-GRD and its advantages over the GFS can be found in Prichard et al. (2014).

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Fig. 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 tax revenues across different regions. The dots represent each country, and the size of the dots represents the magnitude of average resource revenues.

We combine a new dataset on giant oilfields discoveries (Horn, 2011; Arezki et al., 2017) with tax revenue data covering 178 countries for the period 1989 to 2012. The tax revenue data is from the publicly available International Centre for Tax and Development Government Revenue Dataset (ICTD-GRD). The ICTD-GRD has an improved coverage and makes a consistent distinction between resource and non-resource tax revenues.[2]

We find a positive effect of giant oilfields discoveries on non-resource tax revenues before and after production commences. This is mainly due to an increase in non-resource indirect tax revenues. Specifically, non-resource indirect tax revenues increase before and after the actual production following a giant discovery in low-middle income countries but no significant effect is found for high income countries. We also find 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 in the tax rate.

This paper makes two main contributions to the existing literature. First, we show that the abundance of natural resources has a positive effect on non-resource tax revenues. 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 hydrocarbon revenues and other domestic revenues in a panel of 30 hydrocarbon producing countries. The authors found that a one percentage point increase in hydrocarbon revenues 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 (% of GDP). This is problematic because resource revenue to GDP ratio can change due to an increase in the production of natural resources. Non- resource revenue to GDP ratio can 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 non-resource revenue (% of non-resource GDP) on resource revenue (% of resource GDP) using a sample of 15 Latin American and Caribbean countries and found a crowding out effect. 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. Second, we also show that the news of a natural resource discovery could have potential anticipatory effect on non-resource tax revenues even before production commences. This contrasts with the existing empirical studies which assumed that only 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. The next section presents brief theoretical framework followed by a discussion of the data and the empirical strategy in Section 3. Section 4 presents and discusses the empirical results. Section 5 conducts several tests to check the robustness of the results. Finally, the paper concludes in Section 6.

2. Theoretical framework

How does the discovery of a natural resource affect non-resource tax revenues mobilization? In this section, we briefly present the theory guiding the empirical analysis in this paper, drawing largely on the model presented in Besley and Persson (2013).

The model assumes that there are two periods and the government generates revenues from non-resource tax revenues (tax revenues from goods and labor) and resource revenues, where the later is assumed to be stochastic. These revenues are then used to provide public goods, transfers and invest in fiscal capacity. According to Besley and Persson (2013), investment in fiscal capacity is determined by the following equation.

$$\lambda_2 \frac{\delta G(t_2^*, \tau_2)}{\delta \tau_{k,2}} + \frac{\delta Q(t_2^*, \tau_2)}{\delta \tau_{k,2}} - \lambda_1 \frac{\delta F(\tau_1, \tau_2)}{\delta \tau_{k,2}} = 0 \qquad for \quad k = 1, 2 \tag{2.1}$$

where G is the government non-resource tax revenue function, Q the profit (from efforts devoted to tax-reducing activities) function, F, the cost (of fiscal-capacity investments) function, t is the tax rate, $\tau_{k,i}$ is the level of fiscal capacity investment in for tax base k in period i, and λ_i is the marginal value of public fund in period i.

The first term is thus the marginal non-resource tax revenue or future benefit derived from investing in better fiscal capacity. This first term is determined by the non-resource tax revenue function, G, and the marginal value of public fund in period 2, λ_2. The second term is the additional cost imposed on citizens due to investment in better fiscal capacity i.e better fiscal capacity reduces the benefits citizens derive from the non-payment of taxes. Finally, the third term is the marginal cost associated with investment in fiscal capacity weighted by the marginal value of public fund in period 1, λ_1.

The impact on non-resource tax revenues in the future (G_2) is dependent on investment made in fiscal capacity today. When a country discovers a valuable natural resource, it anticipates a significant inflow of future revenues from the exploitation of that resource. This expectation can lower the marginal value of public funds (λ_2), meaning that the immediate need for generating revenue through other means, such as taxation, is perceived to be less urgent. Consequently, the government may have less incentive to invest in enhancing its fiscal capacity – such as improving tax collection systems, expanding the tax base, and enforcing tax compliance – because the anticipated resource wealth diminishes the perceived necessity of such investments.

However, the finite nature of natural resources like oil and gas introduces an element of urgency in ensuring that the wealth generated from these resources is effectively managed. Governments may recognize that resource revenues are temporary and that relying solely on these revenues is unsustainable in the long run. In this context, the prospect of future revenues from an exhaustible resource might actually incentivize the government to invest in building fiscal capacity and developing an effective tax system. By doing so, the government can ensure a stable flow of non-resource tax revenues, even as resource reserves dwindle or become depleted. In such case, the discovery of oil gas should have a positive impact on non-resource tax revenues. Therefore the impact of oil and gas discovery on resource on non-resource revenues is theoretically ambiguous, and thus an empirical question.

Moreover, oil discovery and extraction have the potential to significantly boost non-resource tax revenues through a variety of channels, contributing to overall economic growth and prosperity. While the traditional view has often labeled natural resources as a "curse" due to their association with economic stagnation in resource-rich countries, recent studies have provided evidence that natural resource discoveries, can indeed lead to positive development outcomes (see for example Van der Ploeg and Poelhekke, 2019). Some of the potential channels through which oil discovery and extraction can boost non-resource tax revenues include:

- Increased Economic Activities and Consumption :The discovery of oil could lead to a surge in economic activities, including the development of infrastructure, the expansion of local businesses, and the creation of new industries. This increased activity boosts the overall economic output, leading to higher tax revenues. Indeed, recent studies (e.g. Cavalcanti et al., 2019; Smith, 2015) found that oil discoveries have a positive effect on economic growth and income. For instance, Smith (2015) found that resource discoveries leads to a large increase in GDP per capita levels that persists into the long-term in developing countries. With more income circulating in the economy, people tend to spend more on goods and services. This rise in consumer spending leads to higher sales tax revenues and other consumption-based taxes, leading to a higher non-resource tax revenues.
- Government Investments: Oil revenues provide governments with the means to invest in infrastructure, which enhances the business environment and stimulates economic growth. Improved infrastructure can pave the way for the emergence of new businesses and industries, thereby expanding the tax base. For instance, a portion of Ghana's oil revenue is allocated to fund the national budget, primarily for capital projects, through the Annual Budget Funding Amount (ABFA).[3] Moreover, Smith (2015) found that oil discoveries have a positive and large impact on the capital stock in developing countries.
- Spillover Effects via Foreign Direct Investments: Foreign direct investment (FDI) is crucial for economic development, contributing to job creation (McCaig et al., 2022), higher wages (Alfaro-Ureña et al., 2021), technology and knowledge transfer (Abebe et al., 2022), and the formation of backward and forward linkages with local firms. Oil discoveries have the potential to attract FDI in the non-resource sector, thereby expanding the tax base. For instance, Toews and Vézina (2022) found that natural resource discoveries in Mozambique led to significant non-resource FDI inflows and employment growth, driven by a local FDI job multiplier. Specifically, the authors find that for every new FDI job created in the non-resource sector, an additional four jobs emerged locally, with two of these in the formal sector.
- Backward Linkages: Backward linkages, where local suppliers expand their operations to meet the increased demand from the oil industry, can result in agglomeration effects. This concentration of economic activity in certain regions can further expand the VAT base and other tax revenues. Aragón et al. (2015) found that demand shocks, lead to increased demand for goods and services due to backward linkages, resulting in agglomeration effects (Aragón et al., 2015).
- Increased International Trade: The development of oilfields (see Section 3.2) is essential for extracting oil, but this process often requires specialized materials, equipment, and technologies that may not be readily available within the domestic market. As a result, these resources need to be imported from other countries, which could boost non-resource tax revenues through tariffs, import duties, and other trade-related taxes.

  In addition, foreign exchange earnings from natural resources typically lead to a higher demand for imports, enhancing the value of the domestic import market, particularly in developing economies where local substitutes are limited (Arezki et al., 2021). As a result, the wealth generated from oil could drive an increase in the importation of goods and services, which can be taxed through import duties, further boosting non-resource tax revenues.

3. Data and empirical strategy

In this section, we provide a description of the data, empirical model and the identification strategy. In Section 3.1, we describe the data used in the study. This is followed by the justification of the identification strategy in Section 3.2. The empirical model is specified in Section 3.3.

3.1. Data

The study utilizes two main sources of data in addition to various control variables obtained from different sources.

Non-Resource Tax Revenues Data. The first data is on tax revenues and comes from the International Centre for Tax and Development (ICTD) Government Revenue Dataset (GRD). The version of the data we use, covers the period 1980 to 2016. The ICTD GRD has an improved coverage for most developed and developing countries starting from 1989. There is also a consistent distinction between tax and non-tax revenues using standard system of classification.[4] This gives it an advantage over other sources of government revenues such as the IMF and the World Bank. Furthermore, tax revenues are decomposed into resource and non-resource tax revenues. This is important to adequately capture the impact of natural resources on non-resource tax revenues and its various components. Non-resource tax revenue is defined as tax revenues excluding social contributions and resource tax revenues.

[3] https://www.piacghana.org/wp-content/uploads/2023/06/simplified_guide_to_ghanas_petroleum.pdf

[4] A detailed description of the ICTD-GRD can be found in Prichard et al. (2014).

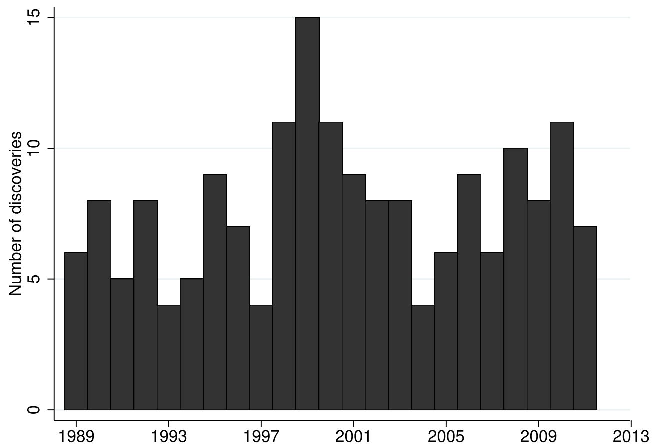


Fig. 2. Number of discoveries across time (1989–2012).

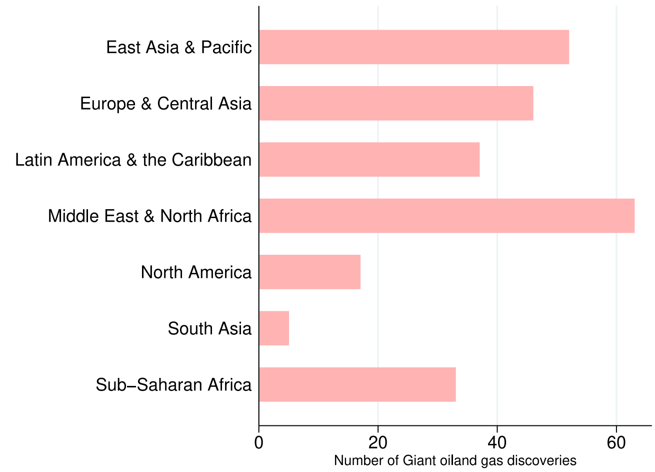


Fig. 3. Number of discoveries over regions (1989–2012).
Notes: The country regional groupings are based on the classification of the World Bank.

Giant oil and gas discoveries. The second dataset 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) from 1868 to 2012. A discovery is considered a giant discovery if it has an estimated URR of at least 500 million barrel of oil equivalent (MMBOE). Since the data on my dependent variables start from 1989 and the data on giant oilfield discoveries end in 2012, we restrict the sample to cover the period, 1989 to 2012. Giant discoveries were made in 48 countries over the period under consideration. We plot the distribution of the number of giant oilfields discovery over time in Fig. 2. One can see there is large variation in the number of discoveries made over time. Fig. 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.

Control and additional variables. Numerous factors influencing tax revenues have been extensively discussed in the literature. These factors encompass population growth, real GDP per capita, economic structure, trade balance, democratic governance, corruption levels, and financial openness. The anticipation is that countries with elevated per capita income, increased financial openness, positive trade balances, and rapid population growth will exhibit higher tax collection. Additionally, a higher level of democracy is expected to correlate with greater tax revenues. Conversely, it is anticipated that countries with a predominant concentration of economic activity in the informal and challenging-to-tax agricultural sector may experience lower mobilization of tax revenues.

We proxy the structure of the economy with agriculture value added (% of GDP). To measure the degree of financial openness, we use 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. Trade openness is defined as the non-resource exports plus non-resource imports to GDP ratio. To measure corruption, we use the 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. The data on population growth, real GDP per capita, the structure of the economy and trade balance are sourced from the World Bank Development Indicators (WDI). Table 1 presents the summary statistics of the main variables. A detailed definition of all the variables and their sources are provided in Table A.2 in Appendix A.

Table 1
Summary statistics (1989 to 2012).

	Mean	Min	Max
Giant oilfield discovery	0.04	0.00	1.00
Non-Resource Tax Revenues			
Non-Resource Tax Revenues (% of GDP)	16.00	0.09	53.87
Direct Tax Revenues (% of GDP)	6.22	0.00	25.02
Indirect Tax Revenues (% of GDP)	10.00	0.02	42.97
Taxes on International Trade (% of GDP)	2.68	−1.57	36.12
Other indirect taxes (% of GDP)	0.40	−2.11	7.91
Other variables			
Real GDP per capita	11 140.79	115.79	111 968.35
Population Growth	1.58	−6.18	16.33
Trade openness (millions)	−1295.20	−837288.00	359 886.09
Non-Resource openness (millions)	1.54	0.00	2568.79
Level of democracy	3.00	−10.00	10.00
Corruption	2.96	0.00	6.00
Financial development	0.27	0.00	1.00

3.2. Identification strategy

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

Upstream petroleum exploitation can be broken down into four 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 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.[5] 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

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

been identified as potentially containing viable oil/gas resources, they are examined in more detail 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 economically feasible to produce from the field, the site is returned to its original state as close as possible. This is known as decommissioning.

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 they had discoveries in the past. Lei and Michaels (2014) showed that giant oilfield discoveries made in the recent past can predict whether a discovery can be made in the subsequent years or not.[6] This is also likely to work in the opposite direction: past discoveries can increase the cost of discovery thereby rendering future discoveries less likely (Arezki et al., 2017). Even in both cases, the exact timing of the giant oil discovery is less likely to be predictable. However, we account for the number of years with at least one giant discovery in the recent past in the empirical analysis.

3.3. 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;

$$Y_{it} = \alpha_i + \theta_t + \sum_{j=0}^{10} \beta_j Discovery_{it-j} + \gamma_1 pastdiscovery_{it} + \delta X_{it-1} + \epsilon_{it} \quad (3.1)$$

where Y_{it} is tax revenues from the non-resource sector (expressed as a percentage of GDP) 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 suggests that the effect might not be immediate but may take time to materialize and last for a period. We exploit these dynamics by including ten lags of the discovery variable.

This implies that β_j comprises 11 parameters because we have 11 Discovery dummies. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery.[7] As indicated in the previous section this accounts for the influence of discoveries made in the recent past on subsequent discoveries in the future.

X_{it-1} is a vector of control variables. In the benchmark results, we control for the level of development (real GDP per capita and population growth) and the structure of the economy. The other control variables described in 3.1 were omitted because some countries had several missing observations. We however, include them in the robustness tests in Section 5. To limit endogeneity issues, the control variables enter the regression with a lag.

[6] The authors showed that the likelihood of a giant discovery in year t increases from about one percent when there was no giant oilfield discoveries in the past 10 years to 87 percent if at least one giant oilfield discovery is made every year in the past 10 years.

[7] We compute this variable for each year and country in the study using the data from Horn (2011).

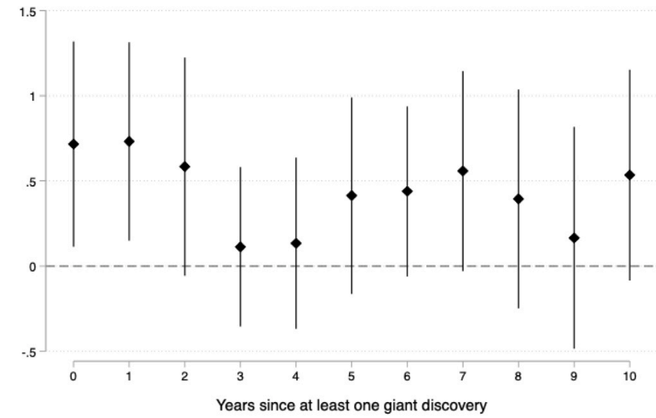


Fig. 4. Intertemporal effect of oil and gas discoveries on non-resource taxes.
Notes: The figure shows the effect of giant oil discoveries on non-resource tax revenues over time. The dots show the point estimates, and the bars indicate 95% confidence intervals. The standard errors are clustered at the country level. All the regressions include country and year fixed effects. The regressions also control for the number of past years between t-20 and t-11 with at least one giant discovery, real GDP per capita, population growth and the structure of the economy.

To investigate the general pattern of what happens in the period after discovery and the production periods as opposed to what happened at a particular point in time, we estimate a version of model (3.1);

$$Y_{it} = \alpha_i + \theta_t + \beta_1 preproduction_{it} + \beta_2 production_{it} + \beta_3 pastdiscovery_{it} + \delta X_{it-1} + \epsilon_{it} \quad (3.2)$$

where preproduction is a dummy variable which takes the value of 1 if there was at least one giant oilfield discovery between t-4 and t. Notice that the average time from discovery to production is 5 years. preproduction therefore captures what happens to non-resource tax revenues during the average five-year period it takes to start production. Production is a dummy variable which takes the value of 1 if at least one giant oilfield discovery was made between t-10 and t-5. This variable on the other hand captures what happens on average 5 years after actual production commences i.e., between 5 to 10 years after at least one giant discovery was made.

4. Empirical results

The main aim of this section is to document the causal impact of giant oil and gas discoveries on non-resource tax revenues. We present and discuss the results from models (3.1) and (3.2) with total non-resource tax revenues as the dependent variable in Section 4.1. In Section 4.2, we decompose total non-resource tax revenues into direct and indirect components. We conclude the section by documenting the main channels through which the non-resource tax revenues are affected by giant oil and gas discoveries in Section 4.3.

4.1. Effect of oil discovery on non-resource tax revenues

In Fig. 4, we graphically display the empirical estimates of the β coefficients from Eq. (3.1) with non-resource tax revenues as the dependent variable. The value of the beta coefficients is displayed on the y-axis while the periods (contemporaneous and 10 years after discovery) are shown in the x-axis.

We observe that all the estimated beta coefficients are positive. Specifically, non-resource tax revenues witnessed an increase in the first year following discovery, followed by a decline in the second year. Subsequently, they stabilized in the 3rd and 4th years, before experiencing another upturn from the fifth year onward. It is worth noting that the positive response in the first year after discovery is

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

	1	2	3
Preproduction	0.740***	0.893***	0.854***
	(0.211)	(0.212)	(0.216)
Production	0.491***	0.700***	0.669***
	(0.189)	(0.200)	(0.207)
Pastdiscovery		0.280***	0.267***
		(0.0723)	(0.0754)
Observation	3018	3018	3018
Adjusted R-squared	0.918	0.919	0.921
Year FE	✓	✓	✓
Country FE	✓	✓	✓
Other control variables			✓

Notes: The dependent variable is the non-resource tax revenues (% of GDP). All regressions include country and year fixed effects. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth and the structure of the economy. Robust standard errors, clustered at the country level, are reported in parentheses. *, ** and *** denotes significance at 10%, 5%, and 1% respectively.

statistically significant, while the responses in the subsequent years are not statistically different from zero.

To ascertain what happens in general during the period following discovery and when production sets in, rather than focusing on a specific point in time, we report estimates of Eq. (3.2) in Table 2. For the sake of brevity, we only focus on column 3 which controls for the number of years with at least one giant discoveries in the recent past, real GDP per capita, population growth and the structure of the economy as done in Fig. 4.

The findings indicate a positive impact of a giant discovery on total non-resource tax revenues during both the average pre-production and production periods. These effects are statistically significant. On average, non-resource tax revenues increase by 0.85 percentage points during the pre-production period and by approximately 0.67 percentage points during the average production period. Also, the discoveries made in the recent past has a positive and statistically significant effect on non-resource tax revenues.

The results presented above diverge from the prevailing literature, which typically indicates a crowding-out effect. As previously mentioned, this discrepancy might arise from differences in methodology employed in these studies. However, it is crucial to consider whether the variance in results is attributable to disparities in data rather than methodological distinctions. To address this, we replicate the outcomes of previous studies using their methodologies but applying the ICTD-GRD data used in our present study. The corresponding results are detailed in Table A.1 in Appendix A.

Notably, these results largely align with a crowding-out effect. Specifically, an additional percentage point increase in resource revenues (as a percentage of GDP) leads to a statistically significant decrease of 0.13 and 0.12 percentage points in non-resource tax revenues and indirect non-resource revenues, respectively. These estimates, although somewhat lower, are comparable to those reported in existing literature. For instance, while Bornhorst et al. (2009) identified an offset of 0.2 percentage points, and Crivelli and Gupta (2014) found an offset of 0.3 percentage points.

Consequently, this suggests that differences in data sources are unlikely to be the primary reason for the observed disparities in results.

4.2. Effect of giant oil discoveries on non-resource direct and indirect tax revenues

The petroleum sector is commonly acknowledged as an enclave and capital-intensive industry, meaning that a relatively low number of direct jobs are generated per unit of invested capital. Conversely, an oil discovery and its subsequent exploitation can result in the import of materials and capital goods, potentially elevating custom duties or fostering spillover effects on local activity, thereby increasing Value Added Tax (VAT). This suggests that different tax revenues might respond differently to a giant oil discovery. In this section, we decompose non-resource tax revenues into direct and indirect components, as the ICTD-GRD data allows for such decomposition.

We first looked at the behavior of non-resource direct and indirect tax revenues over time by estimating model (3.1). The results are shown in Fig. 5. Regarding direct non-resource tax revenues, all beta coefficients, though positive, are not statistically significant for any of the years. Conversely, the indirect component of non-resource tax revenues demonstrated an increase in the year following a discovery, followed by a decline from the second to the fourth year post-discovery, and a subsequent upturn from the fifth year onward. Notably, only the beta coefficients for the first and tenth years after discovery are statistically different from zero. Nevertheless, the impact of giant oilfield discoveries on indirect tax revenue follows a U-shaped pattern, with three distinct phases: an initial increase, a subsequent decline, and a later resurgence. The initial boost in the first year following the discovery could be driven by the commencement of the development phase, during which significant investments are made in constructing the necessary infrastructure to support oil extraction and production. However, the indirect tax revenues decline as the development phase progresses and construction activities begin to wind down. The notable increase in indirect tax revenues starting from the fifth year corresponds to the beginning of the production phase. This resurgence could thus be fueled by the commencement of oil production and the associated economic activities.

Additionally, we analyzed the behavior of these two variables during the average pre-production and production periods by estimating Eq. (3.2). The findings are presented in Table 3. In the preferred specification (column 3), the results indicate a positive yet statistically insignificant impact of giant discoveries on the direct component of non-resource tax revenues in both the pre-production and production periods. In contrast, the indirect component of non-resource revenues tends to increase during the pre-production period across all three specifications (see columns 4 to 6). Specifically, during the pre-production and production periods, indirect non-resource tax revenues increase by 0.57 and 0.65 percentage points, respectively, accounting for the economic structure, level of development, and the occurrence of giant discoveries in the recent past (column 6). Taken together, these results suggest that giant oil and gas discoveries have a significant positive effect on total non-resource tax revenues, primarily driven by a noteworthy positive impact on indirect non-resource tax revenues.

We 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 observed effect. The results are shown in Table 4. It can be seen that tax revenues from the consumption of goods and services experienced an increase in both the pre-production and production era. Trade tax revenues also experienced an increase during the average pre-production period.

Furthermore, in order to gain a deeper understanding of the results, we divide the sample used in the analysis into two groups. The first group is made up of countries classified as high income countries according to the World Bank's classification, while the second subset consists of low and middle-income countries, also determined by the World Bank's classification criteria. This division is driven by the recognition that the same size of a giant oil discovery would have varying impacts on a developed economy such as the USA compared to a developing economy like Ghana. The findings, presented in Table 5, reveal a decline in non-resource revenues during both the pre-production and production periods in high-income countries. However, these effects are not different from zero. Additionally, no statistically significant impact is observed for both direct and indirect non-resource tax revenues in the context of high-income countries.

Table 3
Effect of giant 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	0.127	0.140	0.157	0.498***	0.628***	0.572***
	(0.126)	(0.129)	(0.131)	(0.141)	(0.140)	(0.140)
Production	−0.0603	−0.0421	0.0131	0.560***	0.738***	0.652***
	(0.105)	(0.109)	(0.114)	(0.141)	(0.147)	(0.150)
Pastdiscovery		0.0245	0.0392		0.238***	0.210***
		(0.0420)	(0.0439)		(0.0438)	(0.0463)
Observation	3018	3018	3018	3018	3018	3018
Adjusted R-squared	0.929	0.929	0.930	0.882	0.883	0.885
Year FE	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Other control variables			✓			✓

Notes: The dependent variables are non-resource direct tax revenues (% of GDP) in columns 1 to 3, and non resource indirect tax revenues(% of GDP) in columns 4 to 6. All regressions include country and year fixed effects. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth 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%.

Table 4
Effect of giant oil and gas discoveries on the components of indirect non-resource tax revenues.

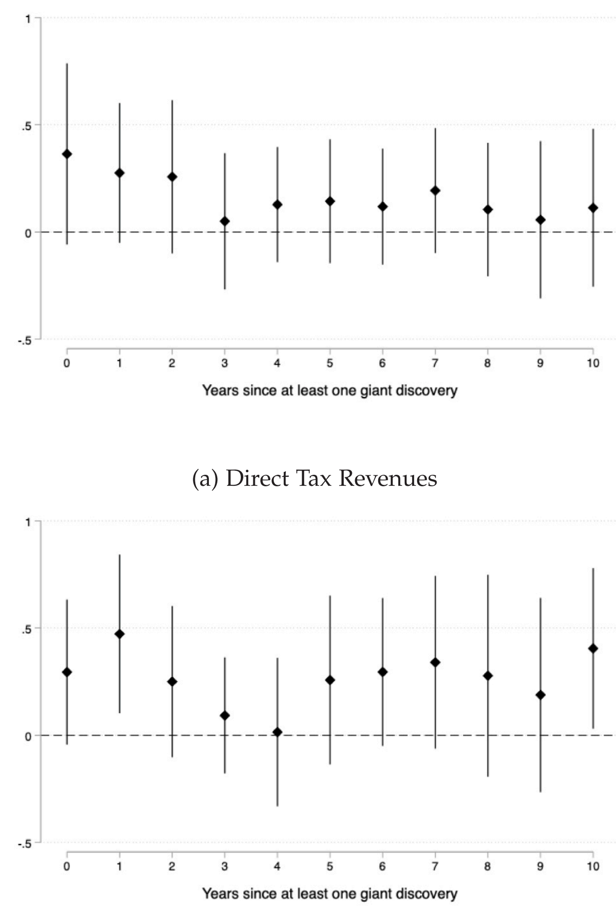
	1	2	3
Preproduction	0.418***	0.243***	0.0547
	(0.125)	(0.0693)	(0.0403)
Production	0.378***	−0.0188	−0.0421
	(0.130)	(0.0822)	(0.0534)
Pastdiscovery	0.163***	0.00168	−0.0367*
	(0.0460)	(0.0232)	(0.0204)
Observation	2902	2903	2724
Adjusted R-squared	0.873	0.844	0.587
Year FE	✓	✓	✓
Country FE	✓	✓	✓
Other control variables	✓	✓	✓

Notes: The dependent variables are tax revenues from goods & services (column 1), trade tax revenues (column 2) and other indirect tax revenues (column 3). They are all measured in percent of GDP. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth 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%.

In contrast, the overall pattern observed in the results thus far remains consistent in the context of low and middle-income countries. Notably, both total non-resource tax revenues and indirect non-resource tax revenues exhibit an upward trajectory during both the pre-production and production periods. Consequently, the findings imply that the influence of giant oil discoveries holds greater significance for low and middle-income countries compared to their high-income counterparts. This findings is consistent with Smith (2015), who found that resource discoveries leads to a large increase in GDP per capita levels that persists into the long-term in developing countries.

4.3. Mechanisms

The findings reveal that discoveries of giant oilfields have a positive impact on non-resource tax revenues throughout both the pre-production and production phases. This positive effect is primarily due to increased revenues from non-resource indirect taxes. A detailed breakdown of non-resource indirect tax revenues indicates that, during the average pre-production period, the boost in indirect tax revenues is largely attributed to tax revenues from the consumption of goods and services, as well as international trade. In contrast, during the average production period, the increase in indirect tax revenues is primarily driven by taxes on the consumption of goods and services.



(a) Direct Tax Revenues

(b) Indirect Tax Revenues

Fig. 5. Intertemporal effect of Giant 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 revenues (panel b) over time. The dots show the point estimates, and the bars indicate 95% confidence intervals. The standard errors are clustered at the country level. All the regressions include country and year fixed effects. The regressions also control for the number of past years between t-20 and t-11 with at least one giant discovery, real GDP per capita, population growth and the structure of the economy.

Table 5
High income vs low–middle income countries.

	High income			Low and middle income		
	nrtax	Direct	Indirect	nrtax	Direct	Indirect
Preproduction	−0.269	−0.278	−0.00770	1.365***	0.385	0.815***
	(0.401)	(0.253)	(0.221)	(0.231)	(0.318)	(0.172)
Production	−0.326	−0.0670	−0.239	1.104***	0.141	0.959***
	(0.418)	(0.230)	(0.267)	(0.221)	(0.128)	(0.169)
Pastdiscovery	−0.0268	−0.107	0.0958*	0.387***	0.112**	0.243***
	(0.106)	(0.0799)	(0.0530)	(0.0937)	(0.0475)	(0.0642)
Observation	937	937	937	2081	2081	2081
Adjusted R-squared	0.953	0.958	0.935	0.868	0.808	0.864
Year FE	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓
Other control variables	✓	✓	✓	✓	✓	✓

Notes: The table presents the estimates of Eq. (3.2) for high income countries and low–middle income countries. nrtax is non-resource tax revenues; direct is non-resource direct tax revenues and indirect is non-resource indirect revenues. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth and the structure of the economy. Robust standard errors, clustered at the country level, are reported in parentheses. *, ** and *** denotes significance at 10%, 5%, and 1% respectively.

As discussed in Section 2, the positive impact on tax revenues from international trade during the average pre-production period can be attributed to the development of oilfields, which often requires the acquisition of specialized materials, equipment, and technologies that are not readily available domestically. This scarcity necessitates the importation of these critical resources from other countries, leading to a substantial increase in imports . For instance, in Angola, all the production machinery were imported (Teka, 2012). As a result, government non-resource tax revenues could be boosted through various channels, including tariffs, import duties, and other trade-related taxes. The increase in trade tax revenue from these specialized imports plays a key role in this positive effect. This broader economic activity often leads to further increases in imports of complementary goods and services. For example, construction materials, machinery, and transport services may also need to be imported to support the development of oilfields. As a result, the surge in import activity can generate additional revenue through trade taxes. Furthermore, Perez-Sebastian et al. (2021) found that countries that make oil discoveries tend to increase tariffs (more protectionist) during the average pre-production years, which may further explain the observed rise in trade tax revenues during this period.

What might explain the positive impact on revenues derived from taxing consumption goods and services—the tax rate or the tax base? To address this question, we assess the reaction of consumption (representing the tax base) and the consumption tax rate to a significant oil discovery shock by estimating model (3.2). The computation of the consumption tax rate is as follows:

$$Consumption \quad tax \quad rate = \frac{tax \quad revenue \quad on \quad goods \quad \& \quad services}{Consumption}$$
$$= \frac{Consumption \quad tax \quad rate * Consumption}{Consumption} \tag{4.1}$$

The results are displayed in Table 6. Notably, the impact on the tax rate during both the pre-production and production periods is statistically indistinguishable from zero. Conversely, consumption, representing the tax base for goods and services, tends to increase in both the pre-production and production periods. This outcome implies that the positive effect of a giant oil discovery on tax revenues from goods and services is primarily attributed to an expansion in the tax base (consumption) rather than a shift in tax policy (tax rate).

There are various ways in which an oil discovery could broaden the consumption tax base during both the preproduction and production periods. During the pre-production phase, essential infrastructure must be established to facilitate oil extraction which could drive the demand for local good services. Also, oil discoveries can attract significant FDI into the non-resource sectors of the economy. The prospect of future oil wealth can make a country more attractive to investors, leading to increased inflows of FDI. This investment not only stimulates economic activity but also expands the consumption tax base as higher incomes are generated during the pre-production era. For example, Toews and Vézina (2022) found that natural resource discoveries in Mozambique led to substantial non-resource FDI inflows and employment growth, driven by a local FDI job multiplier effect.

Once oil extraction begins, the government starts to earn direct revenues from the oil sector, which can have a cascading effect on the broader economy. These revenues can drive consumption by increasing public spending on infrastructure, social services, and other critical areas. Government investments can spur the growth of new businesses and industries, leading to higher incomes and, consequently, an expanded consumption tax base.

Furthermore, oil extraction can trigger local demand shocks, particularly at the community level, as workers and businesses associated with the oil industry generate increased demand for goods and services. These backward linkages can result in agglomeration effects, where businesses cluster together, leading to greater economic activity and an expansion of the VAT base. Aragón et al. (2015) observed these dynamics in local communities where natural resources were exploited, leading to positive spillovers in the local economy. Cavalcanti et al. (2019) also identified positive spillover effects of oil discoveries on local communities in Brazil. These effects were attributed to heightened local demand for non-tradable services, further underscoring the potential for oil discoveries to broaden the indirect tax base through increased consumption and economic activity.

5. Robustness checks

The results so far suggest that the discovery of giant oilfields discovery does have a positive and statistically significant effect on total non-resource tax revenues in both the average pre-production and production periods. In this section, we conduct several checks to test the robustness of this result. All the results are reported in Appendix B.

5.1. Additional control variables

First, as explained in Section 3.3, several variables that can potentially affect tax revenues were omitted from the model due to missing data for some countries. These variables are trade balance, level of democracy, corruption, and financial openness. We include these variables as additional controls in model (3.2). The results are shown in Table B.1. As can be seen from the table, the number of observations reduce drastically. However, the result that giant oilfield discovery has

Table 6
Effect of giant oil and gas discoveries on consumption and average tax rate.

	Consumption tax rate	Consumption (logs)
Preproduction	−0.0102	0.0293**
	(0.0137)	(0.0124)
Production	−0.00901	0.0242**
	(0.0141)	(0.0122)
Pastdiscovery	−0.0251***	0.00553
	(0.00812)	(0.00398)
Observation	2626	2626
Adjusted R-squared	0.511	0.998
Year FE	✓	✓
Country FE	✓	✓
Other control variables	✓	✓

Notes: The dependent variables are consumption tax rate (as defined in Eq. (4.1)) and the log of real consumption. Consumption is defined as the final consumption expenditures in constant local currency units. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. All regressions include country and year fixed effects. The regressions also control for real GDP per capita and population growth. Robust standard errors, clustered at the country level, are reported in parentheses. *, ** and *** denotes significance at 10%, 5%, and 1% respectively.

a positive and statistically significant effect on total non-resource tax revenues still holds.

5.2. Different measures of giant oilfield discoveries

Secondly, we make use of different measures for giant oilfield discoveries. We first test if the result is sensitive to the location of the discovery. Discoveries can be made offshore (which is the typical case) or onshore. We also exclude from the sample discoveries that were made in the past three 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. The results are reported in Table B.2. The results indicates that giant oilfield discovery has a positive and statistically significant effect on total non-resource tax revenues in both the average pre-production and production era for all the different measures for giant oilfield discoveries.

Table A.1
Replication of existing studies.

	(1)	(2)	(3)
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. The dependent variable in column 1 is non-resource tax revenues, non-resource direct tax revenues in column 2 and non-resource indirect revenues in column 3. 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. *, ** and *** denotes significance at 10%, 5%, and 1% respectively.

5.3. Alternate dependent variables

Finally, we make use of three alternative measures of the dependent variable: the growth rate of non-resource tax revenues, non-resource tax revenue per capita and non-resource tax revenues to total tax revenues, to examine if the baseline results are sensitive to alternative measures of the dependent variables. As can be seen from Table B.3, a positive and statistically significant is found for all three alternative measures in both the pre-production and production periods.

6. Conclusion

In this paper, we investigate the effect of natural resources on tax revenue mobilization by exploiting the exogenous variation in the timing of giant oilfields discovery. This approach allows us to deal with the endogeneity of natural resources as the timing of the discovery of giant oilfields is arguably exogenous. In addition, this approach allows us to directly examine the performance of non-resource tax revenue mobilization before and immediately after discovery as well as the period corresponding to the inflow of revenues from the production of oilfields.

We do find that non-resource tax revenues experience an increase in both the pre-production and production periods. This result is robust to alternative measures of giant oil discoveries. This is due to an increase in indirect tax revenues 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 of goods and services. This is mainly driven by an increase in consumption of goods and services. This suggests that oil discoveries offer significant opportunities to broaden the indirect tax base during both the pre-production and production phases. Through the importation of essential materials, the attraction of FDI, government investments, and local economic growth, these discoveries can generate substantial revenues that support long-term economic development. By effectively managing these opportunities, governments can ensure that the benefits of oil wealth extend beyond the resource sector, contributing to a diversified and resilient economy.

Taken together the result suggest that the crowding effect found in the existing literature, could be due to the way the issue has been investigated, where non-resource revenues (as % of GDP) is normally regressed on resource revenues (% of GDP). The results therefore suggest that the abundance of natural resources may not be a reason why countries mobilize less tax revenues.

CRediT authorship contribution statement

Abraham Lartey: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Financial support from Generalitat Valencia GRISOLIA/2018/110 is duly acknowledged.

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Table A.2
Definition and sources of variables.

Variable	Definition	Source
Giant oilfield discovery	A dummy variable that indicates whether a country made at least one giant oil or gas field discoveries during the period under consideration	Horn (2011)
Non-Resource Tax Revenues		
Non-Resource Tax Revenues (% of GDP)	Non-resource tax excluding social contributions expressed as percentage of GDP	ICTD-GRD
Direct Tax Revenues (% of GDP)	Direct taxes excluding social contributions and resource revenue	ICTD-GRD
Indirect Tax Revenues (% of GDP)	Non-Resource Component of Indirect Tax expressed as percentage of GDP	ICTD-GRD
Taxes on International Trade (% of GDP)	Total taxes on international trade and transactions expressed as percentage of GDP	ICTD-GRD
Other indirect taxes (% of GDP)		ICTD-GRD
Other variables		
Real GDP per capita	GDP per capita divided by midyear population in constant local currency unit	WDI
Population Growth	Annual population growth rate	WDI
Trade openness (millions)	Difference between exports and imports of goods in millions	WDI
Non-Resource openness (millions)	Difference between non-resource export and non-resource imports to GDP ratio (in millions)	WDI
Level of democracy	Proxied with polity score. The polity score is computed by subtracting the $p_{autocracy}$ score from the $p_{democracy}$ score; the resulting unified polity scale ranges from +10 (strongly democratic) to −10 (strongly autocratic)	Center for systemic Peace
Corruption	A score based on the assessment of corruption within the political system. This corruption risk index has a minimum score of zero and maximum score of six	ICRG
Financial development	A broad-based measure that considers the depth, access, and efficiency of financial institutions which ranges from zero to one. Higher values means higher degree of financial openness	Svirydzenka (2016)

Data Sources: ICTD GRD: International Center for Tax and Development Government Revenue Dataset, WDI: World Bank Development Indicators and ICRG: International Country Risk Guide.

Table B.1
Effect of giant oil discoveries on non- resource tax revenues: additional control variables.

	nrtax	Direct	Indirect
Preproduction	0.641***	0.113	0.480***
	(0.215)	(0.133)	(0.138)
Production	0.622***	−0.0281	0.579***
	(0.208)	(0.116)	(0.150)
Pastdiscovery	0.133**	−0.00574	0.130***
	(0.0662)	(0.0422)	(0.0400)
Observation	2154	2154	2154
R-squared	0.933	0.942	0.889
Year FE	✓	✓	✓
Country FE	✓	✓	✓
Other control variables	✓	✓	✓

Notes: The table presents the regression of non-resource tax revenues on resource revenues from 1989 to 2012 with additional control variables. The dependent variable in column 1 is non-resource tax revenues, non-resource direct tax revenues in column 2 and non-resource indirect revenues in column 3. 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. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth and the structure of the economy. Robust standard errors, clustered at the country level, are reported in parentheses. *, ** and *** denotes significance at 10%, 5%, and 1% respectively.

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Appendix A. Additional tables

See Tables A.1 and A.2.

Appendix B. Robustness check results

See Tables B.1–B.3.

Appendix C. List of countries in the sample used in the study[8]

Afghanistan, Albania, **Algeria**, **Angola**, Anguilla, Antigua and Barbuda, **Argentina**, Armenia, Aruba, **Australia**, Austria, **Azerbaijan**, Bahamas, The, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, **Bolivia**, Bosnia and Herzegovina, Botswana, **Brazil**, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, **Canada**, Cape Verde, Central African Republic, Chad, Chile, **China**, **Colombia**, Comoros, Congo, Dem. Rep., **Congo, Rep.**, Costa Rica, Cote d'Ivoire, Croatia, Cuba, **Cyprus**, Czech Republic, **Denmark**, Djibouti, Dominica, Dominican Republic, Ecuador, **Egypt**, El Salvador, **Equatorial Guinea**, Eritrea, Estonia, **Ethiopia**, Fiji, Finland, France, Gabon, Gambia, The, Georgia, **Ghana**, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong SAR, China, Hungary, Iceland, **India**, **Indonesia**, **Iran, Islamic Rep.**, **Iraq**, Ireland, **Israel**, Italy, Jamaica, Japan, Jordan, **Kazakhstan**, Kenya, Kiribati, Kosovo, **Kuwait**, Kyrgyz Republic, Lao PDR, Latvia, Lebanon, Lesotho, **Liberia**, **Libya**, Lithuania, Luxembourg, Macao SAR, China, Macedonia, FYR, Madagascar, Malawi, **Malaysia**, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Fed. Sts., Moldova, Mongolia, Montenegro, Montserrat, Morocco, **Mozambique**, **Myanmar**, Namibia, Nauru, Republic of, Nepal, Netherlands, New Zealand, Nicaragua, Niger, **Nigeria**, **Norway**,**Oman**, **Pakistan**, Palau, Panama, Papua New Guinea, Paraguay, **Peru**, **Philippines**, Poland, Portugal, **Qatar**, Romania, Rwanda, Samoa, San Marino, Sao Tome and Principe, **Saudi Arabia**, Senegal, Serbia, Seychelles, **Sierra Leone** , Singapore, Slovak Republic, Slovenia, Solomon Islands, Somalia, South Africa, South Sudan, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, **Sudan** , Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, **Tanzania**,

[8] Countries with at least one giant oilfield discovery during the period under consideration are in bold.

Table B.2
Effect of giant oil discoveries on non- resource tax revenues: alternative measures of giant oilfield discoveries.

	Onshore discoveries	Offshore discoveries	No discovery in the past 3 years	Non-sequential discoveries
Preproduction	0.908***	0.923***	0.699***	0.830***
	(0.250)	(0.256)	(0.200)	(0.195)
Production	1.000***	1.071***	0.738***	0.564***
	(0.300)	(0.309)	(0.204)	(0.200)
Pastdiscovery	0.276***	0.273***	0.269***	0.294***
	(0.0722)	(0.0755)	(0.0757)	(0.0759)
Observation	3018	3018	3018	3018
Adjusted R-squared	0.919	0.921	0.921	0.921
Year FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Other control variables	✓	✓	✓	✓

Notes: The table shows the effect of different measures of giant oil discoveries on non-resource tax revenues. All regressions include country and year fixed effects. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth and the structure of the economy. Robust standard errors, clustered at the country level, are reported in parentheses.*, ** and *** denotes significance at 10%, 5%, and 1% respectively.

Table B.3
Effect of giant oil discoveries on non- resource tax revenues: alternative measures of the dependent variable.

	1	2	3
Preproduction	8.570*	0.0653*	0.0684***
	(4.979)	(0.0379)	(0.00857)
Production	16.21***	0.0522*	0.0752***
	(5.994)	(0.0293)	(0.00850)
Pastdiscovery	4.908***	−0.00210	0.00883***
	(1.472)	(0.0119)	(0.00254)
Observation	3018	3018	3018
Adjusted R-squared	0.678	0.0361	0.107
Year FE	✓	✓	✓
Country FE	✓	✓	✓
Other control variables	✓	✓	✓

Notes: The table shows the effect of giant oil and gas discoveries on different measures of the dependent variable. The dependent variables are non-resource tax revenues per capita in column 1, growth rate of non-resource tax revenues in column 2, and tax structure (non-resource tax revenues to total tax revenues) in column 3. All regressions include country and year fixed effects. Pastdiscovery is the number of past years between t-20 and t-11 with at least one giant discovery. Other control variables include real GDP per capita, population growth and the structure of the economy. Robust standard errors, clustered at the country level, are reported in parentheses. *, ** and *** denotes significance at 10%, 5%, and 1% respectively.

Thailand, Timor-Leste, Togo, Tonga, **Trinidad and Tobago**, Tunisia, Turkey, **Turkmenistan**, Tuvalu, Uganda, Ukraine, United Arab Emirates, **United Kingdom**, **United States**, Uruguay, Uzbekistan, Vanuatu, **Venezuela**, **Vietnam**, West Bank and Gaza, Yemen, Rep., Zambia, Zimbabwe.

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