WIDER Working Paper 2017/10

Natural resources' impact on government revenues

Justine Knebelmann*

January 2017

In partnership with

United Nations University World Institute for Development Economics Research

wider.unu.edu

Abstract: Motivated by the fact that the taxation of natural resources is both crucial and particularly challenging for developing countries, this paper draws on a unique dataset to produce empirical evidence on two issues pertaining to the fiscal impact of oil. On a sample of 31 countries during the 2000s oil price boom, we first assess which country and sector characteristics are correlated with the effective tax on oil, i.e. the share of oil income collected by the government. Secondly, we test whether oil revenue evicts traditional tax revenues. We propose a new methodology to address this question and we conclude to the absence of such an *eviction effect*: we observe no effect of oil revenue on non-oil taxes through taxation channels, and linkages with the non-oil economy seem to yield additional non-oil tax revenues. These econometric analyses are complemented by six comparative case studies of countries observed before and after oil production begins. Historical, institutional and oil sector-specific information allows to account for differences observed in the evolution of the effective tax on oil and of non-oil taxes.

Keywords: taxation, oil, resource revenues
JEL classification: H2, Q33

Tables and figures: all authors own work.

Acknowledgements: I thank UNU-WIDER for support, and the participants of the UNU-WIDER Symposium on Taxation in Developing Countries for helpful comments and suggestions. I also wish to thank Wilson Prichard and Kyle McNabb for the incredible work they are doing with the ICTD Government Revenue Dataset, and for their availability every time I had questions about the data. I am deeply grateful to Denis Cogneau (Paris School of Economics—IRD) and Akiko Suwa-Eisenmann (Paris School of Economics—INRA) for their supervision, insightful comments and support throughout this research. I would also like to thank Serge Matesco and Jérôme Roux from Total E&P for having taken the time to answer my questions about oil contracts. All remaining errors are my own.

---

*Visiting Scholar at Columbia University 2016–17. PhD candidate at the Paris School of Economics starting September 2017; justine.knebelmann@gmail.com.

This study is an outcome of the Symposium on Taxation and Revenue Mobilization in Developing Countries organized by the International Centre for Taxation and Development (ICTD) and the United Nations University World Institute for Development Economics Research (UNU-WIDER). It is part of UNU-WIDER's research project on 'Macro-Economic Management (M-EM)'.

Copyright © UNU-WIDER 2017

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-234-2

Typescript prepared by the Author.

The United Nations University World Institute for Development Economics Research provides economic analysis and policy advice with the aim of promoting sustainable and equitable development. The Institute began operations in 1985 in Helsinki, Finland, as the first research and training centre of the United Nations University. Today it is a unique blend of think tank, research institute, and UN agency—providing a range of services from policy advice to governments as well as freely available original research.

The Institute is funded through income from an endowment fund with additional contributions to its work programme from Denmark, Finland, Sweden, and the United Kingdom.

Katajanokanlaituri 6 B, 00160 Helsinki, Finland

The views expressed in this paper are those of the author(s), and do not necessarily reflect the views of the Institute or the United Nations University, nor the programme/project donors.

1 Introduction

"The economic future of Africa will be determined by whether this opportunity is seized or missed" wrote Collier about natural resources (Collier 2010, p1). More generally, over 50 World Bank client countries are classified as resource-dependent (Barma et al. 2011).[1] Oil, gas and mineral resources are all the more so important for developing countries' economic future as substantial reserves have been uncovered lately - the wave of massive oil and gas discoveries in East Africa since 2010, in Tanzania, Mozambique, Kenya, and Uganda is a striking illustration - and many discoveries are yet to come in countries where the subsoil remains for now less explored than in their richer counterparts. The consequences of natural resources' presence in an economy occur through different channels, yet fiscal revenues from extractive industries are often the main direct effect of the sector for a given country - most often dwarfing both the impact in terms of employment in these capital-intensive sectors[2] and the creation of linkages with the rest of the economy. These additional fiscal resources are much needed in middle- and low-income countries, where government revenues average respectively 25% and 17% of GDP, against 32% in high-income countries.[3]

However, taxing natural resources is a major challenge, for all countries and for developing ones in particular (Barma et al. 2011). Fiscal planning is hindered by the intrinsic characteristics of the tax base: the finite nature and the volatility of rents, the uncertainty regarding reserves and future discoveries, the long timeframe of the exploration-production cycle, implying that fiscal arrangements negotiated years ahead may turn out flawed when the context changes (e.g. a price boom or bust, or new discoveries) - or renegotiated at a high reputational cost for the government. Because of its specificities, the taxation of natural resources is characterized by complicated fiscal settings, combining multiple instruments with targeted exemptions, which render it difficult to administrate efficiently, even more so in low institutional capacity environments. Finally, the size of the rents at stake, the asymmetry between highly capacitated foreign companies and States characterized by weak governance, and the lack of transparency lead to non-negligible tax evasion and corruption - in resource rich countries, the resource sector is the main source of illicit financial flows (Boyce and Ndikumana 2003).

Furthermore, it has been suggested, both in the political science literature and in the work of economists, that resource-rich countries levy less non-resource taxes than their non-resource counterparts, i.e. that there is a substitution of traditional tax revenues by revenues coming from natural resources, or what we call an *eviction effect* (Bornhorst et al. 2009, Crivelli and Gupta 2014, Ossowski and Gonzáles 2012, Thomas and Trevino 2013, Mohtadi et al. 2016). This eviction could be problematic for three main reasons: i) it would lead to higher resource dependence and thus to increased volatility and unpredictability of total fiscal revenues; ii) revenues collected are smaller than potential total revenues, even more so if there are inefficiencies in the taxation of natural resources; iii) finally, historical, political science and economic research have led to the widely shared view that traditional taxation offers opportunities for improvement of accountability and governance, since tax-reliant governments are forced to bargain with their citizens and make policy concessions if they want to maintain taxpayers' compliance (Moore 1966, North 1990, Prichard 2015), whereas the taxation of natural resources is not associated with the same beneficial properties (Ross 2012). The replacement of traditional tax revenues by resource revenues thus falls under the

[1] Barma et al. 2011 classify a country as resource dependent if its ratio of resource revenue to total revenues exceeds 25% over the 2006-2008 period.

[2] An extreme example is Saudi Arabia, where the oil sector accounts for 90% of GDP, but employs only 1.6% of the active labor force and 0.35% of the total population (ILO 2005, cited in Ross 2012).

[3] Average total revenues excluding social contributions and grants for 2012 by income group. Own calculations using ICTD Government Revenue Dataset.

rentier state theory developed in the political resource curse literature: "When governments derive sufficient revenues from the sale of oil, they are likely to tax their populations less heavily or not at all, and the public in turn will be less likely to demand accountability from - and representation in - their government" (Ross 2001, p332).[4] The *eviction effect* is thus the first component of the *rentier state* theory, the second one being the influence of lower non-resource taxes on governance and political institutions.

In spite of its importance in the political economy literature, consistent empirical evidence of this mechanism is still scarce, as Smith and Waldner underline in a recent literature review: "We are thus struck by the large discrepancy between the fundaments of rentier state theory and the weak empirical and theoretical support for it" (Smith and Waldner 2015). Few papers demonstrate its first element - the eviction of traditional tax revenues by resource revenues - in a fully convincing way. Notably, most analyses measure the impact of resource revenues on non-resource taxes measured *as a share of GDP*. Yet, a decrease in this ratio can be the mechanical consequence of the growth of the resource component of GDP, and does not necessarily show a weakening in the government's desire or capacity to tax the non-resource sector. Results are much less straightforward when *non-resource GDP* is used as the denominator, although we find that this would be a more appropriate methodology.

Furthermore, the possible mechanisms through which resource revenues can trigger an *increase* in other tax revenues are rarely described and tested for. Yet, such a synergy can happen for several reasons (Smith 2004, Thies 2010). First, to maximize their revenues from natural resources, resource-rich States invest in the relevant tax administrations' capacity through targeted technical trainings, increases in the budget and staff of these administrations, etc. When the institutions in charge of collecting revenue from natural resources are not completely isolated from those in charge of taxing the non-resource economy, this can potentially benefit both types of taxation: there could be positive spill-overs from the improvement of the capacity to tax natural resources to the capacity to tax other sectors. Secondly, the government can wish to limit its fiscal dependence on natural resources (by fear of volatility, for example), and endeavor to reinforce the non-resource taxation system when resource revenues increase, as noted by Smith: "leaders in many of these states invested their windfall revenues in building state institutions and political organizations that could carry them through the hard times" (Smith 2004, p.232). This is also a frequent recommendation made by the IMF to the tax administrations of resource-rich developing countries. Third, although they are limited, linkages between natural resource sectors and the rest of the economy do exist. In developing economies characterized by widespread subsistence farming and large informality, they can contribute to growth in the formal activities of the economy, making taxation easier. In this case, resource revenues are accompanied by larger non-resource tax revenues, although the relation is not directly related to tax policy or tax administration capacity, but rather to a structural change in the economy caused by the development of the resource sector.

In this paper, we focus on oil and gas producing countries, and we seek to answer the following questions: i) are there strong cross- and within-country variations in the ability to collect oil revenue?[5] Which country or sector characteristics seem most correlated to the share of oil income collected by the government (oil income being the value of oil and gas production)? Because of its particularly strong and increasing dependence on natural resources, and because the continent is also characterized by its poor fiscal capacity and government efficiency in general, we wish to

[4]More precisely, this describes the *taxation effect*, which is one of the channels through which the *rentier effect* operates, the others being the *spending effect* by which resource revenues are used for patronage and targeted spending for the relief of democratic pressures, and the *group formation effect* by which resource revenues are used to prevent to formation of social groups independent from the State (Ross 2001).

[5]Throughout this paper, we use "oil" as a simplification for "oil and gas".

assess whether there is a specificity for Sub-Saharan Africa. ii) What is the impact of oil revenue on non-oil tax revenues? Do we find evidence for an *eviction effect* or a *synergy effect*?

Researchers' interest in these questions is far from being new, but the availability of consistent, comparable cross-country data allowing to analyze government revenues from natural resources over time is very recent. We use the first world-wide government revenues dataset including a standardized measure of resource revenue, the International Centre for Tax and Development Government Revenue Dataset, first released in September 2014.[6] The empirical challenge which arises in both of our research questions - the response of government oil revenue to oil income and the response of non-oil taxes to oil revenue - is the possibility of reverse causality. The first case is the classical one of the reaction of a tax base to the tax rate. For instance, oil companies may choose to divert their activities away from a country if they anticipate a toughening of the fiscal terms, and reduced production can lead to lower tax rates since in many countries the rates of at least some of the fiscal devices increase with quantities of oil produced. In the second case, we could imagine a situation where a government plagued by weaknesses in the collection of non-oil taxes for reasons unrelated to the oil sector decides to rely more on revenues from the latter (Jensen 2011). We thus resort to two types of shocks on the level of oil income that we use as quasi-exogenous variations in our explanatory variables.

We first use a shock on oil price, analyzing a sample of 31 oil producing countries during the oil price boom of the 2000s. After remaining below 40 USD per barrel from 1986 onwards, the annual average oil price skyrocketed from 17.6 USD per barrel in 1998 to 102 USD per barrel in 2008.[7] We consider the increase in oil income due to the price shock as a quasi-exogenous variation in the level of oil income.

The effective tax rate on oil, defined as the ratio of government oil revenue to oil income, is 45% on average over the period.[8] It is the lowest in Central Asia, Latin America and Sub-Saharan Africa, and the highest in East Asian and MENA countries. It sharply increased between 2005 and 2012, and the econometric analysis shows that more precisely, for a given country, the tax on oil is progressive with respect to quantities rather than to prices. This means that on average countries of the sample didn't have fiscal mechanisms in place which allowed them to take fully advantage of the oil price boom. The effective tax rate appears to be positively associated with OPEC membership, with the fact of having the National Oil Company as the main operator, and with offshore production. It is lower for Sub-Saharan African countries.

To study the impact of oil revenue on non-oil taxes, we prefer to analyze how non-oil taxes vary for each additional dollar of oil revenue, rather than to use oil revenue and non-oil tax expressed as a share of GDP - as is mostly done in the literature (Bornhorst et al. 2009, Crivelli and Gupta 2014, Thomas and Trevino 2013 and Mohtadi et al. 2016) - because of the sensitivity of the results to the choice of the denominator (GDP or non-oil GDP) otherwise. Whether we use oil revenue as such or the price shock on oil income to limit endogeneity issues, we don't observe an *eviction effect* - on the contrary, a slight *synergy effect* is visible. However, it disappears when we control for growth in the non-oil economy: our conclusion is that there is no direct impact of oil revenue on non-oil taxes through taxation channels in our sample, but that linkages with the non-oil economy seem to yield additional non-oil taxes. We also replicate models more similar to what is found in the literature and the absence of the *eviction effect* is confirmed.

[6] We use the June 2016 version of the ICTD Government Revenue Dataset, hereafter referred to as the ICTD GRD.

[7] Prices in constant 2015 USD.

[8] Throughout this paper we use the term "effective tax" although all included components of government oil revenue are not necessarily taxes strictly speaking, for example oil revenue usually include profits of National Oil Companies.

As a second approach, we analyze a shock on oil quantities, in six case studies for countries where oil was discovered within the timeframe of our dataset (1980-2012): Belize, Chad, Equatorial Guinea, Sudan, Timor-Leste and Vietnam. This shock is not fully exogenous with respect to a country's fiscal profile, since exploration activities are influenced by the fiscal agreements existing even before discoveries and commercial production start, and by a country's fiscal and institutional environment in general. However, examining these examples is the closest we can get to a natural experiment setting given the mechanisms under study and the data available. We use detailed historical, institutional and oil-sector related features to account for the observed differences in the way oil income is taxed, and on the impact of oil revenue on non-oil taxes.

After describing the data, we focus on the determinants and characteristics of the effective tax rate during the oil price boom in Section 2, and on the impact of oil revenue on non-oil taxes in Section 3. The comparative case studies are developed in Section 4.

2 The 2000s Oil Price Boom and Effective Tax Rates

2.1 Oil Sector Characteristics and Effective Tax Rates

The effective tax rate stems both from the fiscal design of the oil sector - which results from a bargaining between the State and the operators - and from a State's enforcement capacity. In the long run, fiscal designs have become more favorable to governments over time (Ross 2012, Van Meurs 2008). This is in large part due to the increased number of countries where the sector is controlled by a National Oil Company, since they supposedly allow governments to capture larger shares of oil income, and their power relative to International Oil Companies has increased over years (Mahdavi 2014, Ross 2012, Vivoda 2009). Yet, weaker States are still in an unfavorable position, hence our interest in assessing whether there is a specificity for Sub-Saharan Africa. Their weaker bargaining power and the necessity to compensate companies for geopolitical risks could lead to lower statutory rates (Barma et al. 2011), and higher levels of corruption or tax evasion might decrease the effective tax rate even further, even more so in periods of high prices (Van Meurs 2008).

The particularity of OPEC countries needs to be noted. Higher effective tax rates are expected for this group of countries, for several reasons. First founded in the 1960's for its members to share information on contracts, the organization later incorporated an objective of coordinated negotiation strategies (Ross 2012). The organization has an influence on world prices, possibly shifting them in a way that bolsters the effective tax rate of its members. Finally, all but two OPEC countries in our sample have a National Oil Company as the main operator.

Fiscal devices in the oil sector can have fixed rates, rates which depend on quantities, rates which depend purely on prices, and rates which depend on profitability. Countries usually combine multiple instruments which differ across fields (Van Meurs 2008). A change in the statutory rate during the increase in prices in the 2000s can occur because of: i) a pre-existing fiscal design with rates depending on prices and/or profitability, or providing for an additional profits tax; or ii) the drafting of a new legislation and/or renegotiations.[9] Overall however, it has been observed that at the eve of the price boom, the majority of oil countries did not have pre-existing fiscal designs allowing them to capture a larger share of oil income: "When oil prices increased five-fold from 2002 through 2010 government take percentages in most countries went down. This is because most systems were regressive especially with respect to oil prices. They are not designed to handle a

[9] As in Algeria where a windfall profit tax was implemented in 2007, or in Ecuador where all petroleum contracts where renegotiated in 2005.

price shock like that" (Johnston and Johnston 2015, p14; see also Johnston 2007, Mahdavi 2014).

Finally, geological conditions such as whether production is onshore or offshore also play an important role in the determination of the effective tax rate. Offshore production is more costly and geologically risky, so companies can demand higher shares of income as a compensation. On the other hand, offshore fields are less vulnerable to geopolitical risks. Furthermore, if a government wishes to change the fiscal design in the context of the price boom, the higher level of sunk costs for offshore fields could lead to a lower elasticity of the tax base, and thus higher revenue collections than what would be observed for onshore fields given the change in the fiscal design.

2.2 Data

In this section and the following (Sections 2 and 3), we study a sample of 31 oil and gas producers between 1998 and 2012, listed in Table 1.[10] We use the total resource revenues variable from the ICTD GRD as a proxy for government revenues from oil and gas, since countries producing significant quantities of other natural resources are excluded.[11] The primary sources for this variable are the IMF Article IV Country Reports. Resource revenues include royalties (a percentage of production or of the value of sales), taxes (corporate income tax, additional taxes on profits), production sharing (the share of production going to the government in Production Sharing Agreements),[12] and profits of the National Oil Company if applicable. A limitation is that the definition of resource revenues used by the IMF is not perfectly consistent across time and across countries. For example, countries may differ in whether indirect taxes paid by oil companies are counted as resource revenue (Prichard et al. 2014), and in whether downstream resource activities are included or not (International Monetary Fund 2014). However, the ICTD GRD is the first dataset offering a measure of resource revenues from a single source over such a long time span and with a world-wide coverage. As a measure of the tax base for resource revenues, we use oil and gas income from Mahdavi and Ross' Oil and Gas Dataset, calculated as quantities extracted in a given year multiplied by the per-unit world price (Mahdavi and Ross 2015). Ideally, the tax base for oil revenue would be measured by oil income minus costs of production, or oil rents, and by taking into account price differences across countries.[13] An option could be to use the resource rent variable of the World Bank's Word Development Indicators (WDI) dataset, but this variable has some strong limitations: since production costs are not available at a country-year level, they are estimated for a few countries and at a fixed point in time. Furthermore, the calculation method used by the World Bank lacks transparency.[14] Nevertheless, all the analyses presented in this paper have been done using the WDI resource rents variables, and results were consistent.

We compute the effective tax rate on oil in year t as the ratio of total resource revenues in t to

[10] The ICTD GRD provides data until 2013, but we drop observations for that year because we have the oil revenue variable for only 12 countries out of 31.

[11] In none of the countries of our sample do mineral rents account for more than 5.9% of GDP at any point in time, and they exceed 1.5% of GDP in 5 countries only.

[12] Two main fiscal settings for oil and gas exist worldwide: the concession system, in which companies can privately own the resource, and pay taxes and royalties to the government, and the Production Sharing Agreement system, in which companies finance the exploration and production at their own risks, are reimbursed within the limit of a "cost stop", and share the extracted hydrocarbons with the State. There is no intrinsic difference in the share of oil income each system allocates to the government (Johnston 2007, Johnston and Johnston 2015).

[13] Indeed, considering that in a given year, the same volumes produced by two countries generate the same profits beyond production costs is an approximation: in 2008, the cost of extracting one barrel of oil ranged from 1.80 USD in Saudi Arabia to 31.4 USD in Canada, and the price of a barrel of oil ranged from 38 USD in Canada to 53 USD in Nigeria (Ross 2012).

[14] See World Bank 2015 for a presentation of the methodology used to compute the rents variable.

oil and gas income in t.[15] This measures the share of income generated in a year by the oil sector which was reported as having entered the government's budget that same year. In a few cases, the government could be gaining *more* than what we measure by the effective tax rate, in countries like Angola or Nigeria where barter contracts are signed with the IOCs, who directly invest in infrastructure projects as a way to make their payment to the government. Yet, these cases remain limited in the period under study (Ross 2012).

Table 1 displays the average effective tax rate for each country between 1998 and 2012, ranked in descending order, and Table 2 shows regional averages. The overall average is 45.52%, and country averages range from 17.90% (Côte d'Ivoire) to 77.98% (Kuwait). Regional discrepancies are quite wide: the average rate is the highest for Middle East and North African countries (55.82%) and East Asia (55.18%), while it is the lowest for Central Asia (24.02%, corresponding to Azerbaijan and Kazakhstan), Latin America (36.71%) and Sub-Saharan Africa (38.06%). Figure 1 shows the evolution of the average effective tax rate for the same countries, but over a longer period (1980-2012). The overall decrease between 1986 (53.00%) and 2004 (36.12%), and the sharp increase after 2004, are in line with the long-term evolutions described by Van Meurs 2008.[16]

We create a dataset with the general features of a country's oil sector which can have an impact on the effective tax rate and for which data is available. An offshore dummy takes value one if at least some of the country's production is offshore; a "main operator" variable indicates whether the entity producing the largest volumes is a National Oil Company, one of the "Majors", or another oil company. The oil and gas Majors are BP, Chevron, ExxonMobil, Shell, and Total. They are expected to have a higher bargaining power than other private companies. For simplicity of the interpretation, we consider operators which are contributing to oil income in t when analyzing how this income is taxed in t, meaning that the variables refer to those which are active in *production*.[17] We calculate age of production using the first year of positive oil income in the Mahdavi and Ross Oil and Gas Dataset, or, if the country was not independent at the time, the year of independence, since what we are interested in is a country's experience in negotiating oil contracts, and/or the age of the contracts it negotiated. Finally, we code a dummy variable indicating whether a country is an OPEC member.[18] The oil sector variables are from the US Energy Information Administration Country Analysis reports, the Natural Resource Governance Institute country profiles, BP, Chevron, ExxonMobil, Shell and Total's online accessible resources, *A Barrel Full* website, and country specific sources, by order of precedence (see Table A9 in the Appendix for a full list of country-specific sources). Very few changes in these variables occur within the decade under study, therefore they cannot be used in regressions which control for country fixed effects. In cases where one of these characteristics changes over time, we choose the value corresponding to what was applicable for the longest number of years over the 1998-2012 period.[19] Oil prices are from the

[15]Total resource revenues from the ICTD GRD are converted in nominal dollars using the WDI exchange rate.

[16]He attributes the decline between 1984 and 2004 to the opening up of new exploration areas and a decrease in prices, and the post-2004 increase to the limited new acreage and increasing prices.

[17]This could be discussed since companies which are exploring could already have an influence on the effective tax rate even if the oil income which is taxed are not theirs yet, and some payments are made by an operator before it starts production, like signature or discovery bonuses.

[18]Angola and Ecuador joined OPEC in 2007 only, they are coded as non-OPEC. Indonesia left OPEC in 2009 (and joined again in 2016), it is coded as OPEC member.

[19]Obviously, it would be very useful to include variables on each country's fiscal setting: statutory royalty, tax and production sharing rates, existence of a windfall profits tax when prices increase, whether or not the contracts were renegotiated during the oil price boom, etc. However, three main challenges prevent us from creating such a database: first, this information is not always publicly available. Second, within a country, fiscal conditions vary from one oil field to another, so we would need to compute some country averages weighing for the importance of each field, which would require precise infra-country level data. Finally, when there are changes in the legislation, they don't necessarily apply immediately, nor to all fields in the country. This renders the task particularly difficult.

historical oil price tables by inflationdata.com.

In addition to resource revenues, all government revenue variables are taken from the ICTD GRD. Total revenues, total taxes, direct taxes and indirect taxes are always computed exclusive of social contributions (and grants), as the authors suggest is the most comparable across countries (Prichard et al. 2014). When analyzing the impact of oil revenue on non-oil revenue, in Sections 3 and 4.3, we use the non-oil *tax* variables rather than non-oil *revenues*, since non-tax revenues are harder to break down into their resource and non-resource components (Prichard et al. 2014). Industry, service and agriculture value-added are from the WDI. Non-oil industry value-added is calculated as industry value-added minus oil income. To replicate the methodology found in the literature in our Appendix, we use non-oil GDP computed by subtracting oil income to GDP, and the following control variables: GDP per capita, computed using the ICTD GDP and the WDI population figures, a State capacity score computed by averaging the "Control of corruption" and "Government effectiveness" scores of the Worldwide Governance Indicator dataset,[20] the share of agriculture in the non-oil economy, computed as the ratio of the agriculture value-added to non-oil GDP, and non-oil openness to trade calculated as the ratio of non-oil exports plus imports (both from the WDI) to non-oil GDP.

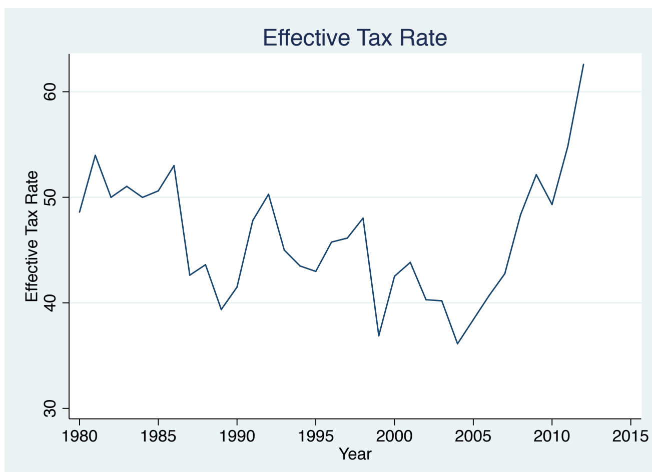

Figure 1: Average Effective Tax Rate for Oil and Gas 1980 - 2012

Note: The effective tax rate is calculated as the ratio of oil revenue (proxied by total resource revenues, source: ICTD GRD) to oil and gas income (volumes multiplied by world prices, source: Ross-Mahdavi Oil and Gas Dataset). Countries included are those listed in Table 1.

2.3 Methodology

We run regressions with oil revenue as the explained variable and oil income as a regressor, first with countries' time-unvarying oil sector characteristics to study their influence on the effective tax rate, before including country fixed effects to study the average features of the taxation of oil income.

[20] Available for 1996, 1998, 2000, 2002-2008

Table 1: Country Averages of Oil Income and Government Oil Revenue 1998-2012

Country	Oil Income (%GDP)	Oil Revenue (%GDP)	Effective Tax Rate (ranked desc. order)
Kuwait	57.57	44.26	77.98
Brunei Darussalam	61.52	44.29	75.40
Libya	61.82	44.62	71.38
Iraq	65.60	44.29	68.30
Timor-Leste	54.48	32.49	66.89
United Arab Emirates	30.48	19.75	63.31
Saudi Arabia	51.99	32.58	61.46
Mexico	7.40	4.28	56.37
Vietnam	10.72	5.65	54.84
Bolivia	19.30	10.68	51.85
Nigeria	31.26	16.42	51.17
Cameroon	9.92	4.98	51.11
Algeria	55.42	25.82	50.08
Indonesia	9.88	4.14	46.27
Angola	75.24	33.51	44.94
Egypt	16.24	6.18	42.52
Malaysia	15.69	5.88	41.42
Sudan	18.21	8.64	41.37
Equatorial Guinea	86.89	34.59	40.23
Syrian Arab Republic	30.01	10.4	38.64
Yemen	64.95	21.86	34.01
Gabon	51.60	16.40	32.30
Iran Islamic Rep	39.02	11.46	30.44
Congo Rep	87.39	25.71	29.26
Ecuador	20.40	4.51	28.51
Chad	25.95	11.09	27.98
Azerbaijan	63.60	17.38	26.66
Trinidad and Tobago	49.76	12.54	25.56
Kazakhstan	39.77	8.53	21.18
Belize	3.63	1.52	18.57
Cote d'Ivoire	5.13	0.91	17.90
Average	37.25	18.28	45.52

Note: Oil Revenue is the government's total resource revenues (source: ICTD GRD). Oil income is the volume of oil and gas produced multiplied by world prices (source: Ross-Mahdavi Oil and Gas Dataset). The effective tax rate is calculated as the ratio of oil revenue to oil income.

Table 2: Average Effective Tax Rate by Region 1998-2012

	Average	**Obs.**
Region		
East Asia and Pacific	55.18	64
Central Asia	24.02	29
Latin America and Caribbean	36.71	60
Middle East and North Africa	55.82	123
Sub-Saharan Africa	38.06	114
Total	45.22	390

Note: The effective tax rate is calculated as the ratio of oil revenue (proxied by total resource revenues, source: ICTD GRD) to oil and gas income (volumes multiplied by world prices, source: Ross-Mahdavi Oil and Gas Dataset). Countries included are those listed in Table 1.

2.3.1 Pooled OLS with Oil Sector Characteristics

The baseline model is:

$$\frac{OIL\_REV_{it}}{GDP_{it}} = \beta_0 + \beta_1 \frac{OIL\_INC_{it}}{GDP_{it}} + \beta_2 \left(\frac{OIL\_INC_{it}}{GDP_{it}}\right)^2 + \beta_3 X_{it} + \mu_t + \epsilon_{it} \quad (1)$$

where $\frac{OIL\_REV_{it}}{GDP_{it}}$ is the ratio of oil revenue to GDP in country i in year t. $\frac{OIL\_INC_{it}}{GDP_{it}}$ is the ratio of oil income to GDP. β_1 measures the effective tax rate and β_2 measures how it varies with the level of oil income. X_{it} is a vector of country's i time-unvarying oil sector characteristics. The coefficients found for these variables show how the share accruing to the government varies with these sector characteristics for a given level of oil income. μ_t is a year fixed effect.

In a second specification, we control for fluctuations in GDP, to see by how much oil revenue varies for each additional dollar of oil income. We express oil revenue (resp. oil income) as the variation in oil revenue (resp. oil income) between t-1 and t relative to GDP in t-1, where all values are expressed in t-1 USD using the USD GDP deflator:

$$\begin{aligned}\frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} &= \beta_0 + \beta_1 \frac{OIL\_INC_{it} - OIL\_INC_{i,t-1}}{GDP_{i,t-1}} \\ &+ \beta_2 \frac{(OIL\_INC_{it})^2 - (OIL\_INC_{i,t-1})^2}{GDP_{i,t-1}} + \beta_3 X_{it} + \mu_t + \epsilon_{it} \quad (2)\end{aligned}$$

The denominator for the square term is also GDP_{t-1} for the unit to be the same as for oil revenue and oil income. Results from this regression inform on the reaction (in dollars) of oil revenue to a one dollar increase in oil income (following Cogneau and Rouanet 2015).

Finally, because of potential reverse causality, we use the price shock on oil income as an instrument for the evolution in oil income. Indeed it is not correlated to observed or unobserved country-specific covariates, yet, it is presumably highly correlated to the actual evolution in oil income. Following Cogneau and Rouanet 2015, we compute it as the difference between oil income in t-1 re-evaluated at the oil price OP in t and oil income in t-1, over GDP in t-1:

$$\frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{\frac{OP_t}{OP_{t-1}} OIL\_INC_{i,t-1} - OIL\_INC_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{(\frac{OP_t}{OP_{t-1}} OIL\_INC_{i,t-1})^2 - (OIL\_INC_{i,t-1})^2}{GDP_{i,t-1}} + \beta_3 X_{it} + \mu_t + \epsilon_{it} \quad (3)$$

All variables are expressed in t-1 USD using the US GDP deflator. Specification (3) informs on how much went to the government budget for each additional dollar of oil income attributable to the increase in prices.

A limitation of this methodology is that all countries are not pure price-takers (the price shock in that case not being exogenous to country characteristics), notably OPEC countries have an influence on world oil prices. Therefore, all regressions are also run without OPEC countries.

2.3.2 Average Features of the Relation between Oil Income and Oil Revenues for a given Country

We rewrite equations (1) to (3) adding country fixed effects γ_i, and dropping time-unvarying country characteristics (equations 4 to 6). The square of the oil income terms allow to assess whether on average the collection of oil revenue is progressive or regressive, with respect to oil income i.e. quantities multiplied by prices (equations 4 and 5) and with respect to prices (equation 6). Since the initial designs were regressive with respect to prices in a large majority of fiscal settings (as described in Section 2.1), observing progressivity of the tax in specification (6) (positive β_3 and/or β_4 coefficients) would imply that it is driven by a few countries of the sample which did have progressivity clauses, and/or that the number of adjustments in the fiscal designs during the 2000s was sufficient to make the tax progressive on average. Lagged oil income terms allow to observe whether some fiscal mechanisms are based on oil income from the previous year.[21]

$$\frac{OIL\_REV_{it}}{GDP_{it}} = \beta_0 + \beta_1 \frac{OIL\_INC_{it}}{GDP_{it}} + \beta_2 \frac{OIL\_INC_{i,t-1}}{GDP_{i,t-1}} + \beta_3 \left(\frac{OIL\_INC_{it}}{GDP_{it}}\right)^2 + \beta_4 \left(\frac{OIL\_INC_{i,t-1}}{GDP_{i,t-1}}\right)^2 + \mu_t + \gamma_i + \epsilon_{it} \quad (4)$$

$$\frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{OIL\_INC_{it} - OIL\_INC_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{OIL\_INC_{i,t-1} - OIL\_INC_{i,t-2}}{GDP_{i,t-1}} + \beta_3 \frac{(OIL\_INC_{it})^2 - (OIL\_INC_{i,t-1})^2}{GDP_{i,t-1}} + \beta_4 \frac{(OIL\_INC_{i,t-1})^2 - (OIL\_INC_{i,t-2})^2}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (5)$$

$$\frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{\frac{OP_t}{OP_{t-1}} OIL\_INC_{i,t-1} - OIL\_INC_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{\frac{OP_{t-1}}{OP_{t-2}} OIL\_INC_{i,t-2} - OIL\_INC_{i,t-2}}{GDP_{i,t-1}} + \beta_3 \frac{(\frac{OP_t}{OP_{t-1}} OIL\_INC_{i,t-1})^2 - (OIL\_INC_{i,t-1})^2}{GDP_{i,t-1}} + \beta_4 \frac{(\frac{OP_{t-1}}{OP_{t-2}} OIL\_INC_{i,t-2})^2 - (OIL\_INC_{i,t-2})^2}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (6)$$

[21] Or simply whether there is a discrepancy between the two accounting calendars. We first estimate equations (4) to (6) with the square terms only, and with a lagged term only. Results are not displayed as they are consistent with what we observe when both are included. They are available upon request.

2.4 Results

2.4.1 Pooled OLS with Oil Sector Characteristics

Table 3 displays means difference t-tests for the effective tax rate across the oil sector characteristics included in the regressions.[22] The effective tax rate is on average higher when the main operator is the National Oil Company and when a country is a member of OPEC,[23] and lower in Sub-Saharan African countries, in line with the background information given in Section 2.1. It is higher when there is at least some offshore production.

Results from specifications (1), (2) and (3), where we control for these characteristics simultaneously as well as for age of oil production and for the level of oil income, are displayed in Tables 4 to 6, in columns (1), (2) and (3) respectively. The offshore and age of production variables are included in the three Tables. In Table 4, we add the main operator variable, in Table 5 the OPEC dummy, and in Table 6 the Sub-Saharan Africa dummy. We consistently observe that oil revenue is significantly higher in countries with at least some offshore production. The sign of the age of production variable is always negative, which could be due to the fact that older contracts are less favorable to governments, in line with the background information of Section 2.1. Notably, the fact that the coefficient is significant in the third columns of Tables 4 and 5, corresponding to equation (3), shows that for a same price shock, older producers have a smaller increase in oil revenue, possibly suggesting that older fiscal settings are less successful in capturing additional revenue when prices increase. In Table 4, we observe that the coefficient indicating that the main operator is the NOC (vs a Major) is always positive, and significant in the first column. However, this no longer holds as soon as we also control for OPEC membership: when both the main operator and the OPEC variables are included, only the latter is significant and positive (not displayed). Table 5 shows that the positive correlation between OPEC membership and the share of oil income captured by the government is quite substantial. The "OPEC effect" and the "NOC effect" are hard to disentangle. However, our regressions suggest that the "OPEC effect" is driving the results. This is confirmed by the fact that when we run the models presented in Table 4 *without* OPEC countries, the main operator variable is no longer significant (not displayed).

Table 6 shows that the effective tax rate is indeed on average lower in Sub-Saharan African countries even when controlling for other characteristics, however the coefficients are not significant. The lower effective tax rate in Sub-Saharan Africa could be driven by the lower proportion of OPEC members compared to the MENA and East Asia regions, and/or by the fact that in none of the Sub-Saharan African countries is the NOC the main operator (it is a Major in all but three countries).

This underlines the strong relationships between the different oil sector/country characteristics which are non-randomly linked to a country's ability to capture oil revenue, and the impossibility to find satisfactory counterfactuals when studying the impact of these characteristics. Nevertheless, these models have allowed to uncover some interesting descriptive evidence.

2.4.2 Average Features of the Relation between Oil Income and Oil Revenues for a given Country

Results for specifications (4), (5) and (6) are displayed in Table 7. Results from column (1) (equation 4) show that in the average country, when oil income increases by one percentage point of GDP, oil revenue increases by 0.33 percentage points. Column (2) (equation 5) shows that when for each additional dollar of oil income holding GDP constant, oil revenue grows by 0.29 dollars.

[22] We keep the variables for which results are consistent across specifications.

[23] OPEC countries in our sample are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia and United Arab Emirates (UAE).

Table 3: Difference in Effective Tax Rates across Oil Sector Characteristics

Effective Tax Rate Onshore vs Offshore			
	Onshore	Offshore	Difference
Effective Tax Rate	37.01	47.46	-10.45***

Effective Tax Rate Private Company vs NOC			
	Private	NOC	Difference
Effective Tax Rate	40.29	52.91	-12.62***

Effective Tax Rate OPEC vs Non-OPEC countries			
	Non-OPEC	OPEC	Difference
Effective Tax Rate	40.09	57.48	-17.39***

Effective Tax Rate Sub-Saharan Africa vs Other Regions			
	Other	SSA	Difference
Effective Tax Rate	48.18	38.06	10.12***

Note: The effective tax rate is calculated as the ratio of oil revenue (proxied by total resource revenues, source: ICTD GRD) to oil and gas income (source: Ross-Mahdavi Oil and Gas Dataset). Oil sector characteristics are defined by country for the whole 1998-2012 period. The offshore dummy is equal to one if there is at least some offshore production. The main operator is the operator which produces the most oil and/or gas during the period, it can be the NOC (National Oil Company), or Private, i.e. either one of the Majors or another private company. OPEC countries in our sample are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia and UAE. See country-specific sources in Table A9 in the Appendix. The third column displays the result of a t-test of equality of means.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

More precisely the variation in oil revenue is more than proportional to the variation in oil income, since the square of the oil income term has a positive and significant coefficient, although very small. Finally, column (3) shows a stronger impact on oil revenue when the evolution in oil income is instrumented by the price shock: oil revenue grows by 0.51 dollars for each additional dollar of oil income due to a price shock. This could mean that the fiscal instruments linking oil revenue to prices or profitability are characterized by higher rates than those based on quantities.[24] In column (3) the square term is no longer significant. This shows that on average, the effective tax is not progressive with respect to prices. This is in line with the background information from Section 2.1 (Johnston 2007, Mahdavi 2014, Johnston and Johnston 2015). We run the same regressions without OPEC countries, and results are qualitatively similar.[25]

[24] However this could also be observed if on average both quantities and prices increase each year, and a larger coefficient on the price shock is expected to account for an identical variation in oil revenue.

[25] Our observations also hold when we run the regressions without the observations flagged "treat with caution" in the ICTD GRD.

Table 4: Determinants of Effective Tax on Oil: Pooled OLS with the Main Operator Variable

VARIABLES	(1) Oil Revenue (%GDP)	(2) Var. in Oil Rev.	(3) Var. in Oil Rev.
Oil Income (%GDP)	0.698***		
	(0.169)		
Square of Oil Income (%GDP)	-0.00287		
	(0.00180)		
Main Operator = 2, NOC	7.219**	0.460	0.480
	(3.386)	(0.606)	(0.672)
Main Operator = 3, Other	3.043	-0.913	1.090
	(3.716)	(0.877)	(2.127)
Offshore	8.338***	1.140	1.569**
	(3.023)	(0.678)	(0.658)
Age of Production	-0.0337	-0.0219	-0.0206*
	(0.0617)	(0.0144)	(0.0108)
Var. in Oil Income		0.244***	
		(0.0824)	
Sqr. of Var. in Oil Income		1.10e-06***	
		(2.85e-07)	
Price Shock on Oil Income			0.495***
			(0.0626)
Sqr. of Price Shock on Oil Income			7.16e-07*
			(3.62e-07)
Constant	-13.36**	-0.679	-3.270*
	(4.961)	(1.677)	(1.606)
Observations	375	343	343
R-squared	0.656	0.603	0.569
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Pooled OLS regression of government oil revenue on oil income (volumes multiplied by price) for 1998-2012 in 31 oil countries (listed in Table 1) with year fixed effects. In column (1) oil revenue and oil income are expressed as a share of GDP. In column (2), oil revenue and oil income are both computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). In column (3), variation in oil revenue is the same as in column (2). Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. In columns (2) and (3) the square term for oil income is divided by 10^6 because the coefficient being very small, it would otherwise appear as zero. The main operator is the operator which produces the most oil and/or gas during the period, it can be the NOC (National Oil Company), one of the Majors (reference), or Other i.e. another private company. The offshore dummy is equal to one if there is at least some offshore production. Age of production is the number of years since oil production began, or the number of years since independence. Standard errors are clustered by country.

Table 5: Determinants of Effective Tax on Oil: Pooled OLS with the OPEC dummy

VARIABLES	(1) Oil Revenue (%GDP)	(2) Var. in Oil Rev.	(3) Var. in Oil Rev.
Oil Income (%GDP)	0.538***		
	(0.185)		
Square of Oil Income (%GDP)	-0.00139		
	(0.00194)		
Offshore	6.168**	0.840	1.644**
	(2.867)	(0.592)	(0.735)
Age of Production	-0.0395	-0.0194	-0.0267*
	(0.0477)	(0.0131)	(0.0144)
OPEC	9.170***	1.010**	0.882
	(3.180)	(0.411)	(0.579)
Var. in Oil Income		0.244***	
		(0.0834)	
Sqr. of Var. in Oil Income		1.07e-06***	
		(2.80e-07)	
Price Shock on Oil Income			0.486***
			(0.0548)
Sqr. of Price Shock on Oil Income			6.90e-07*
			(3.64e-07)
Constant	-8.274*	-0.705	-3.027**
	(4.631)	(1.580)	(1.380)
Observations	375	343	343
R-squared	0.676	0.604	0.570
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Pooled OLS regression of government oil revenue on oil income (volumes multiplied by price) for 1998-2012 in 31 oil countries (listed in Table 1) with year fixed effects. In column (1) oil revenue and oil income are expressed as a share of GDP. In column (2), oil revenue and oil income are both computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). In column (3), variation in oil revenue is the same as in column (2). Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. In columns (2) and (3) the square term for oil income is divided by 10^6 because the coefficient being very small, it would otherwise appear as zero. OPEC countries in our sample are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia and UAE. The offshore dummy is equal to one if there is at least some offshore production. Age of production is the number of years since oil production began, or the number of years since independence. Standard errors are clustered by country.

Table 6: Determinants of Effective Tax on Oil: Pooled OLS with SSA dummy

VARIABLES	(1) Oil Revenue (%GDP)	(2) Var. in Oil Rev.	(3) Var. in Oil Rev.
Oil Income (%GDP)	0.695***		
	(0.156)		
Square of Oil Income (%GDP)	-0.00280*		
	(0.00164)		
SSA	-5.469	-0.511	-1.195
	(3.326)	(0.678)	(0.910)
Offshore	8.174**	0.964	1.950**
	(3.616)	(0.690)	(0.827)
Age of Production	-0.0135	-0.0166	-0.0288
	(0.0603)	(0.0152)	(0.0170)
Var. in Oil Income		0.243***	
		(0.0844)	
Sqr. of Var. in Oil Income		1.12e-06***	
		(2.87e-07)	
Price Shock on Oil Income			0.491***
			(0.0554)
Sqr. of Price Shock on Oil Income			7.16e-07*
			(3.58e-07)
Constant	-8.293	-0.381	-2.546*
	(5.033)	(1.593)	(1.333)
Observations	375	343	343
R-squared	0.639	0.602	0.571
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Pooled OLS regression of government oil revenue on oil income (volumes multiplied by price) for 1998-2012 in 31 oil countries (listed in Table 1) with year fixed effects. In column (1) oil revenue and oil income are expressed as a share of GDP. In column (2), oil revenue and oil income are both computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). In column (3), variation in oil revenue is the same as in column (2). Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. In columns (2) and (3) the square term for oil income is divided by 10^6 because the coefficient being very small, it would otherwise appear as zero. SSA is a dummy taking value one for Sub-Saharan African countries. The offshore dummy is equal to one if there is at least some offshore production. Age of production is the number of years since oil production began, or the number of years since independence. Standard errors are clustered by country.

Table 7: Features of Effective Tax on Oil using Country Fixed-Effects

VARIABLES	(1) Oil Revenue (%GDP)	(2) Var. in Oil Revenue	(3) Var. in Oil Revenue
Oil Income (%GDP)	0.332**		
	(0.122)		
Lag of Oil Income (%GDP)	0.342		
	(0.219)		
Square of Oil Income (%GDP)	-0.00134		
	(0.00105)		
Lag of Sqr. Oil Income (%GDP)	-0.000756		
	(0.00132)		
Var. in Oil Income		0.294**	
		(0.139)	
Lag of Var. in Oil Income		-0.146	
		(0.111)	
Sqr. of Var. in Oil Income		1.32e-06***	
		(4.76e-07)	
Lag of Sqr. Var. in Oil Income		5.93e-08	
		(1.97e-07)	
Price Shock on Oil Income			0.510***
			(0.0697)
Lag of Price Shock on Oil Income			0.170
			(0.113)
Sqr. of Price Shock on Oil Income			6.89e-07*
			(3.92e-07)
Lag of Sqr. Price Shock on Oil Income			1.41e-07
			(3.68e-07)
Constant	-2.965	3.957	-1.377
	(3.466)	(2.438)	(1.932)
Observations	360	327	327
R-squared	0.462	0.598	0.405
Number of countries	31	31	31
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of government oil revenue on oil income (volumes multiplied by price) for 1998-2012 in 31 oil countries (listed in Table 1) with country and year fixed effects. In column (1) oil revenue and oil income are expressed as a share of GDP. In column (2), oil revenue and oil income are both computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). In column (3), variation in oil revenue is the same as in column (2). Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. In columns (2) and (3) the square terms for oil income are divided by 10^6 because the coefficient being very small, it would otherwise appear as zero. Standard errors are clustered by country.

3 Did Oil Revenue from the 2000s Oil Price Boom evict Non-Oil Taxes?

3.1 Discussion of the Literature

The impact of oil revenue on non-oil taxes, whether it be positive (*synergy effect*) or negative (*eviction effect*), can occur through different channels: changes in the statutory rates and in the objectives of the tax administrations (*tax policy effect*); changes in the tax administration's capacity (*tax capacity effect*): spill-overs from efforts in the collection of oil revenue to the taxation of the non-oil economy and/or deliberate investments in tax capacity could contribute to a *synergy effect*, while conversely, reduced monitoring and incentives for the taxation of the non-oil economy would lead to an *eviction effect*. Finally, structural shifts in the economy due to the oil sector could also lead to a statistical relationship between oil revenue and non-oil taxes, although the mechanisms are not purely linked to tax policy or tax capacity. An expansion in the economy's formalization, for example through the growth of suppliers for the oil companies, can contribute to a *synergy effect* (as described for Chad in Section 4.3, IMF 2006). Conversely, the decrease in the importance of sectors providing a base which is easier to tax (possibly through a "Dutch disease" effect), and/or an increase in the share of firms enjoying special exemptions (if firms trading with the oil companies benefit from more lenient fiscal terms), would contribute to an observed *eviction effect*. Studies which test for an *eviction effect* insist on the *tax policy* and *tax administration capacity effects*, in line with the political resource curse literature, and do not mention these structural effects, which is a limitation in their theoretical framework.[26]

Bornhorst et al. 2009 find that a one percentage point increase in the oil revenue-to-GDP ratio leads to a 0.16 percentage points decrease in non-oil tax-to-GDP ratio, on a sample of 30 oil producing countries between 1992 and 2005. On a sample of 26 oil countries over the 1992-2009 period, Crivelli and Gupta 2014 find that for each additional percentage point of GDP in oil revenue, there is a reduction in non-oil taxes of about 0.15 percentage points of GDP.[27] However, we do not find these results fully convincing, since non-resource taxes are expressed as a share of total GDP, and as the authors themselves note: "if resource revenue-to-GDP increases due to a sharp increase in resource production, non resource revenue may appear depressed relative to GDP simply because of the increased income and the coefficient estimates may be biased downwards." (Crivelli and Gupta 2014, p.96). As a solution, both papers include an additional specification where non-oil taxes are expressed as share of non-oil GDP, but in that case they also change the denominator for oil revenue, expressing it as a share of oil GDP. This is not in line with the way the *eviction effect* is defined in the literature, since this ratio is a measure of the effective tax on oil rather than a measure of the importance of oil revenue in the economy (Ossowski and Gonzáles 2012 also express their disagreement with Bornhorst et al. 2009 on this point). Mohtadi et al. 2016 find that a one percentage point of GDP increase in resource revenues leads to a 0.02 percentage point of GDP decrease in taxes on individuals, also using the ICTD GRD, although with a larger sample than ours (37 countries, not limited to oil ones, and between 1980 and 2010). They don't provide robustness checks using the tax ratio as share of non-resource GDP, since they argue that including GDP per capita as a control variable allows to control for the mechanical decrease of the non-oil tax-to-GDP ratio entailed by an increase in GDP due to oil. However, in our replications of these models using our data, the negative relationship between oil revenue on non-oil taxes is not robust to a change in the denominator from GDP to non-oil GDP, whether or not we control for GDP per

[26] Bornhorst et al. 2009, Crivelli and Gupta 2014, Ossowski and Gonzáles 2012 and Thomas and Trevino 2013 control in part, but not fully, for a potential *structural shift effect* by controlling for agriculture and openness.

[27] Their samples of countries are similar to ours, they differ by 6 and 7 countries out of 31 and 26 respectively.

capita. Furthermore, their results are no longer in line with their theory when they include both OECD and non-OECD countries and use oil income instead of oil revenue as a regressor: true, the coefficient for the lagged oil income variable is negative, but with a smaller magnitude than the coefficient of on the contemporaneous oil income term, which is large and positive,

The evidence presented in Ossowski and Gonzáles 2012 is more in line with the way we define the *eviction effect*, since they find a negative impact of resource revenues on the ratio of non-resource taxes to *non-resource* GDP, but their results are for Latin America only. Jensen 2011 also uses the ratio of non-resource taxes to non-resource revenues, but the regressor of interest is computed as the ratio of resource revenues to total revenues (the "resource intensity" of fiscal revenues). The problem in this case is that a decrease in non-resource taxes, unrelated to the resource sector, would increase the "resource intensity" ratio, while at the same time decreasing the explained variable, leading to a negative relationship between the two even when there has been no interplay between resource revenue and non-resource taxes. Thomas and Trevino 2013 find that a one percentage point of GDP increase in resource revenue leads to a 0.08 to 0.12 decrease in non-resource revenues as a percent of GDP, but their results are not significant when non-resource revenues are expressed as a share of non-resource GDP. Overall, these studies do not offer consistent evidence that oil revenue has a negative impact on non-oil taxes once we control for the mechanical effect of an increase in GDP.

Conversely, Thies 2010 finds that oil exporters have higher tax-to-GDP ratios, hinting to the fact that they may have "invested in building state institutions that enable increased revenue extraction in other areas" (Thies 2010, p.328). However, the dataset he uses does not allow to make the distinction between oil and non-oil taxes as rigorously as the ICTD GRD.

We provide results for models in line with these papers from the literature in our Appendix. However, because of the high dependence of the results on the choice of the denominator (GDP versus non-oil GDP) and of the potential flaws in the calculation of non-oil GDP, we prefer to phrase the question in terms of "by how much do non-oil taxes react to a one dollar increase in oil revenue", neutralizing the influence of changes in GDP. We contribute to the existing literature by suggesting an alternative specification to study the interplay between oil and non-oil taxes.

3.2 Methodology

To control for fluctuations in GDP, we use the variation of non-oil taxes and oil revenue between t-1 and t over a constant denominator, GDP in t-1. This specification is similar to what is done in equation (5) of Section 2.3. To make its form more intuitive, we run an illustrative regression linking the variation in total revenues to evolutions in each of its subcomponents:

$$\frac{TOT\_REV_{it} - TOT\_REV_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{TOT\_TAX_{it} - TOT\_TAX_{i,t-1}}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (7)$$

where TOT_REVit, OIL_REVit and TOT_TAXit are respectively total revenues, oil revenue and total non-oil tax in country i in year t, and μ_t and γ_i are a time and a country fixed effect. All amounts are expressed in t-1 USD using the US GDP deflator. Coefficients β_1 and β_2 show by how much total revenues increase for a one dollar increase in oil revenue and total tax respectively. Results are in column (1) of Table A2 of the Appendix: as expected, the coefficients are all approximately equal to 1, since total revenues are the sum of oil revenue and total tax. A one dollar increase in oil revenue (resp. in total tax) leads to a one dollar increase in total revenue. We run the same regression breaking-down total tax into direct and indirect tax (column 2 of Table A2).

After this illustration of the nature of our specifications, our first regression of interest to study how oil revenue affects non-oil tax is:

$$\frac{NON\_OIL\_TAX_{it} - NON\_OIL\_TAX_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{OIL\_REV_{i,t-1} - OIL\_REV_{i,t-2}}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (8)$$

where β_1 shows by how much non-oil tax changes for each additional dollar of oil revenue. We include a lagged oil revenue term, expressed over GDP_{t-1} for it to be in the same unit as the contemporaneous oil revenue term.

We then correct for the potential endogeneity of oil revenue by using the price shock on oil income as an instrument for the variation in oil revenue, as in equation (6) in Section 2.3, and akin to Cogneau and Rouanet 2015. This is also in line with Jensen 2011, who like us uses oil price as an instrument when analyzing the impact of oil revenue on non-oil taxes. We rewrite equation (8), replacing the variable for oil revenue by the price shock on oil income:

$$\frac{NON\_OIL\_TAX_{it} - NON\_OIL\_TAX_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{\frac{OP_t}{OP_{t-1}} OIL\_INC_{i,t-1} - OIL\_INC_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{\frac{OP_{t-1}}{OP_{t-2}} OIL\_INC_{i,t-2} - OIL\_INC_{i,t-2}}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (9)$$

Equations (8) and (9) are estimated for three types of non-oil tax variables: total non-oil tax, and its subcomponents direct and indirect non-oil tax.

The next step, after estimating the relationship between oil revenue and non-oil tax, is to control for evolutions in the non-oil economy and to see how that affects the results. We wish to disentangle the taxation channels (*tax policy* and *tax administration capacity* effects) from the structural shift effects.

A preliminary analysis consists in assessing which sector(s) of the economy each component of revenue is associated with. Ideally we would want to decompose GDP into three components: i) the "pure" oil sector, ii) activities related to the oil sector (linkages, e.g. machinery supply, catering on oil production sites, etc.), and iii) activities unrelated to oil. To our knowledge, such data is not available with sufficient coverage for our sample. Therefore, we rely on the decomposition of the economy into industry, service and agriculture value-added, considering that "pure" oil activities fall under industry value-added, and noting that: i) industry value-added also includes non-oil activities; ii) activities triggered by the oil sector without being directly part of it (linkages) can potentially be found both in industry value-added and service value-added. We run the following regression:

$$\frac{TOT\_REV_{it} - TOT\_REV_{i,t-1}}{GDP_{i,t-1}} = \beta_0 + \beta_1 \frac{IND\_VA_{it} - IND\_VA_{i,t-1}}{GDP_{i,t-1}} + \beta_2 \frac{SERV\_VA_{i,t} - SERV\_VA_{i,t-1}}{GDP_{i,t-1}} + \beta_3 \frac{AGRI\_VA_{it} - AGRI\_VA_{i,t-1}}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (10)$$

where the dependent variable is in turn total revenue, total tax, direct tax, indirect tax and oil revenue. IND_VA_{it}, $SERV\_VA_{it}$ and $AGRI\_VA_{it}$ are respectively industry value-added, service value-added and agricultural value-added of country i in year t. Results are presented in Table A3 of the Appendix. Unsurprisingly, the sector which contributes the most to total revenues is industry (column 1), and we observe that this is completely driven by the oil sector, since the coefficient for industry value-added is not significant for any of the non-oil tax variables (columns 2 to 4), and is of a comparable magnitude as for total revenues in the regression of oil revenue (column 5). Conversely, service value-added is the only sector for which we observe a significant coefficient in the regressions of non-oil taxes, and its contribution to non-oil tax seems to be shared equally between direct tax and indirect tax: for one additional dollar of service value-added, direct taxes increase by 0.052 dollars and indirect taxes by 0.061 dollars. The agricultural sector doesn't appear as a significant contributor to non-oil taxes.

To refine this preliminary analysis, we decompose industry value-added into oil and non-oil industry, by substracting oil income from industry value-added. However, for many of our observations, the resulting non-oil industry value-added is negative, highlighting both the fact that non-oil industry is quasi non-existing in some of these countries, and the imperfection of our measure of non-oil industry. We drop observations with a negative non-oil industry and display the results in Table A4 of the Appendix. Only 14 countries remain in the sample. Additionally, the variation in non-oil industry is significant for total and oil revenue only, and not for non-oil taxes. This could mean that the "non-oil industry value-added" variable still includes some direct oil activities. For all these reasons, the variation in service value-added appears as the key variable to control for the variations in the non-oil economy that could be correlated with variations in non-oil taxes. We choose to include it in our preferred specifications: we rewrite equations (8) and (9) adding a term for the variation in service value-added (and lagged variation in service value-added):

$$\begin{aligned}\frac{NON\_OIL\_TAX_{it} - NON\_OIL\_TAX_{i,t-1}}{GDP_{i,t-1}} &= \beta_0 + \beta_1 \frac{OIL\_REV_{it} - OIL\_REV_{i,t-1}}{GDP_{i,t-1}} \\ &+ \beta_2 \frac{OIL\_REV_{i,t-1} - OIL\_REV_{i,t-2}}{GDP_{i,t-1}} + \beta_3 \frac{SERV\_VA_{it} - SERV\_VA_{i,t-1}}{GDP_{i,t-1}} \\ &+ \beta_4 \frac{SERV\_VA_{i,t-1} - SERV\_VA_{i,t-2}}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (11)\end{aligned}$$

$$\begin{aligned}\frac{NON\_OIL\_TAX_{it} - NON\_OIL\_TAX_{i,t-1}}{GDP_{i,t-1}} &= \beta_0 + \beta_1 \frac{\frac{OP_{it}}{OP_{i,t-1}} OIL\_INC_{i,t-1} - OIL\_INC_{i,t-1}}{GDP_{i,t-1}} \\ &+ \beta_2 \frac{\frac{OP_{i,t-1}}{OP_{i,t-1-2}} OIL\_INC_{i,t-2} - OIL\_INC_{i,t-2}}{GDP_{i,t-1}} + \beta_3 \frac{SERV\_VA_{it} - SERV\_VA_{i,t-1}}{GDP_{i,t-1}} \\ &+ \beta_4 \frac{SERV\_VA_{i,t-1} - SERV\_VA_{i,t-2}}{GDP_{i,t-1}} + \mu_t + \gamma_i + \epsilon_{it} \quad (12)\end{aligned}$$

We also run regressions in which we control both for service value-added and non-oil industry value-added for the countries for which it is possible, although they are not our preferred specifications for the reasons described above.

Finally, we also estimate regressions more similar to what is found in the literature to see if results are different using the ICTD GRD. We first estimate a model similar to Bornhorst et al. 2009 and Crivelli and Gupta 2014:

$$\frac{NON\_OIL\_TAX_{it}}{GDP_{it}} = \beta_0 + \beta_1 \frac{OIL\_REV_{it}}{GDP_{it}} + \beta_2 \frac{OIL\_REV_{i,t-1}}{GDP_{i,t-1}} + \beta_3 GDP\_pc_{i,t-1}$$
$$+ \beta_4 STATE\_CAPACITY_{i,t-1} + \beta_5 AGRICULTURE_{i,t-1} + \beta_6 OPEN_{i,t-1} + \mu_t + \gamma_i + \epsilon_{it} \quad (13)$$

$\frac{NON\_OIL\_TAX_t}{GDP_t}$ is the ratio of non-oil taxes to GDP, and $\frac{OIL\_REV_t}{GDP_t}$ is the ratio of oil revenue to GDP. We include a lagged oil revenue term. Controls are time varying characteristics which can contribute in explaining a State's non-oil tax ratio, we follow the literature (Bornhorst et al. 2009, Crivelli and Gupta 2014): GDP_pc is the log of GDP per capita, $AGRICULTURE$ is the share of agriculture in the non-oil economy, $OPEN$ is non-oil openness to trade, and $STATE\_CAPACITY$ is the State capacity score.[28] The control variables are lagged to limit endogeneity issues. γ_i is a country fixed effect and μ_t is a year fixed effect.

To distinguish the mechanical effect of growth in oil GPD on the tax-to-GDP ratio from the actual change in non-oil taxes, we compute the ratio of non-oil taxes to non-oil GPD, as in Ossowski and Gonzáles 2012:

$$\frac{NON\_OIL\_TAX_{it}}{NON\_OIL\_GDP_{it}} = \beta_0 + \beta_1 \frac{OIL\_REV_{it}}{GDP_{it}} + \beta_2 \frac{OIL\_REV_{i,t-1}}{GDP_{i,t-1}} + \beta_3 GDP\_pc_{i,t-1}$$
$$+ \beta_4 STATE\_CAPACITY_{i,t-1} + \beta_5 AGRICULTURE_{i,t-1} + \beta_6 OPEN_{i,t-1} + \mu_t + \gamma_i + \epsilon_{it} \quad (14)$$

The other variables are the same as in equation (13). β_1 shows by how many percentage points of non-oil GDP non-oil taxes react when oil revenue increases by one percentage point of GDP.

3.3 Results

The sample is reduced to 22 countries once we drop countries for which data on total, direct and indirect non-oil taxes is missing, or for which we don't have sectorial value-added.[29] Table A1 in the Appendix displays for each country average total revenues and non-oil taxes over the period (the sample averages are 28.57% and 8.71% of GDP respectively). Figure A1 plots the average non-oil tax-to-non-oil GDP ratio over the average oil revenue-to-GDP ratio. We observe a negative relationship, confirming the hypothesis that countries with more oil revenue collect less non-oil taxes. Our econometric analysis aims to assess whether the increase in oil revenue during the oil price boom led to a decrease in non-oil taxes *in a given country*.

Results from our first specification (equation 8) are displayed in Table 8: we do not see an eviction of non-oil taxes by oil revenue. On the contrary, the coefficients are all positive, and significant for total tax (column 1) and indirect tax (column 6): a one dollar increase in oil revenue is associated with a 0.012 dollar increase in total tax. Estimating equation (9) shows that a one dollar price shock on oil income is associated with a 0.023 increase in total tax (Table 9 column 2). The coefficients for indirect taxes are positive but non significant (columns 5 and 6). For direct taxes, the coefficients of the price shock in t are negative though not significant, and the lag of the price shock has a positive and significant coefficient (columns 3 and 4).

[28] A country's non-oil tax ratio is expected to be positively related to its level of income per capita, to its openness to trade, and to its State capacity, and negatively related to the share of agriculture (Bornhorst et al. 2009, Crivelli and Gupta 2014).

[29] Countries which are dropped are: Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria and Vietnam.

Overall, these results reject the hypothesis of a systematic and substantial *eviction* of non-oil tax by oil revenue, and could potentially hint to a *synergy effect*, since all coefficients are positive except the ones of the price shock for direct taxes, and four of them are significant. However, the robustness of this *synergy effect* would need to be confirmed.

When we investigate further by controlling for the evolution in service value-added (results of equation 11, displayed in Table 10), the coefficients of the variation in oil revenue almost all become negative though significant only for direct taxes. For a one dollar increase in oil revenue, and controlling for service value-added, direct taxes decrease by 0.018 dollars (column 4). The coefficients for indirect taxes are smaller and non significant (columns 5 and 6), and the overall relationship between oil revenue and total tax is also negative but non-significant (columns 1 and 2). The coefficients of the variation in service value-added are positive and significant with magnitudes similar to what was observed when analyzing their contribution to non-oil taxes in Table A3 of the Appendix (equation 10). When using the price shock on oil income (equation 12, results displayed in Table 11), the possible *eviction effect* completely disappears: all the coefficients but one are positive.[30] However they are not significant, suggesting that there is no robust relationship between oil revenue and non-oil tax when we control for the non-oil economy.

In the Appendix we display results when controlling for evolutions in the non-oil industry in addition to services (Table A5 and A6). Interestingly, the negative coefficients for direct taxes are no longer significant in the regression with the variation in oil revenue: the slight *eviction effect* visible in Table 10 isn't robust. None of the coefficients on the price shock are significant in Table A6.

Therefore, the potential *synergy effect* visible in Tables 8 and 9 actually seems to be explained by evolutions in the non-oil economy, probably due to linkages with the oil sector, which would explain why we observe a positive sign on the oil revenue variables when we do not control for these variations in the non-oil economy. When we do control for them, we first suspect a slight *eviction effect* (Table 10), but it is not robust to the utilisation of the price shock on oil income as a quasi-exogenous variation in oil revenue, nor to the inclusion of the variation in non-oil industry value-added in addition to service value-added.

Therefore, our conclusion is that there is no substantial direct effect of oil revenue on non-oil tax through taxation channels (either positive or negative). Linkages with the non-oil economy seem to yield additional non-oil tax revenue in our sample during the years of the oil price boom. A possible extension could be to try decomposing the non-oil encomy in a more refined way into activities which are related to the oil sector and those which are disconnnected.

Regarding the comparison with the literature, Table A7 in the Appendix shows results from the model expressing non-oil tax as a share of GDP (equation 13): we do see a negative relationship between the oil revenue-to-GDP ratio and non-oil tax-to-GDP, however the coefficients aren't significant, and the coefficients for the lagged oil revenue term are positive (though non significant). Although our samples are not identical, it is worth noting that Mohtadi et al. 2016 also find a positive coefficient on the lagged oil revenue variable in their regression on non-OECD countries with the ICTD GRD resource revenue variable.[31] When we change the denominator of the non-oil tax variable to non-oil GDP (equation 14, Table A8 in the Appendix), the sign on oil revenue turns positive, as in our preferred specifications, although not significant. The lagged oil revenue variable has an opposite sign. Overall, this comparison with the literature confirms that the hypothesis of a systematic eviction of non-oil tax by oil revenue is rejected.

[30] The one for direct taxes when no lag is included, column (3), is negative though it isn't significant.

[31] Their explained variable is the ratio of taxes on individuals - a component of direct taxes - to GDP.

Table 8: Variation in Oil Revenue and Non-Oil Taxes

VARIABLES	(1) Var. in Tot. Tax	(2) Var. in Tot. Tax	(3) Var. in Direct Tax	(4) Var. in Direct Tax	(5) Var. in Indirect Tax	(6) Var. in Indirect Tax
Var. in Oil Revenue	0.0124*	0.0257	0.00493	0.0133	0.00651	0.0205**
	(0.00604)	(0.0161)	(0.00438)	(0.0103)	(0.00389)	(0.00979)
Lag of Var. in Oil Rev.		0.00881		0.0146		0.00899
		(0.0171)		(0.0103)		(0.0111)
Constant	0.261	-0.794	-0.0826	-0.232	0.330	-0.775*
	(0.895)	(0.486)	(0.212)	(0.154)	(0.811)	(0.391)
Observations	229	206	206	183	210	187
R-squared	0.135	0.223	0.151	0.180	0.086	0.203
Number of Countries	22	22	22	22	22	22
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of non-oil taxes on government oil revenue for 1998-2012 in 22 oil countries (countries listed in Table 1 excluding Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) with country and year fixed effects. Oil revenue and non-oil taxes are both computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table 9: Price Shock on Oil Income and Variation in Non-Oil Taxes

VARIABLES	(1) Var. in Tot. Tax	(2) Var. in Tot. Tax	(3) Var. in Direct Tax	(4) Var. in Direct Tax	(5) Var. in Indirect Tax	(6) Var. in Indirect Tax
Price Shock on Oil Income	0.0192	0.0230*	-0.00273	-0.00162	0.0195	0.0189
	(0.0131)	(0.0116)	(0.00581)	(0.00507)	(0.0140)	(0.0125)
Lag of Price Shock on Oil Income		0.0133		0.0116*		0.0107
		(0.0120)		(0.00643)		(0.0100)
Constant	-0.108	-0.828*	-0.0380	-0.0694	-0.261	-0.788*
	(0.799)	(0.448)	(0.176)	(0.138)	(0.735)	(0.388)
Observations	253	232	230	209	235	213
R-squared	0.138	0.187	0.161	0.174	0.102	0.170
Number of Countries	22	22	22	22	22	22
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of non-oil taxes on price shock on oil income for 1998-2012 in 22 oil countries (countries listed in Table 1 excluding Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) with country and year fixed effects. Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. Non-oil taxes are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table 10: Variation in Oil Revenue and Non-Oil Taxes controlling for sectorial GDP

VARIABLES	(1) Var. in Tot. Tax	(2) Var. in Tot. Tax	(3) Var. in Direct Tax	(4) Var. in Direct Tax	(5) Var. in Indirect Tax	(6) Var. in Indirect Tax
Var. in Oil Revenue	-0.0174	-0.0144	-0.0194**	-0.0179*	-0.00569	-0.00230
	(0.0168)	(0.0169)	(0.00880)	(0.00947)	(0.0163)	(0.0143)
Lag of Var. in Oil Rev.		-0.0131		0.00139		-0.00681
		(0.0106)		(0.0123)		(0.0137)
Var. in Serv VA	0.144***	0.117***	0.0523***	0.0553**	0.0565**	0.0260
	(0.0279)	(0.0274)	(0.0170)	(0.0205)	(0.0262)	(0.0203)
Lag of Var. in Serv VA		-0.00188		-0.00815		0.00535
		(0.0147)		(0.00565)		(0.00631)
Constant	-0.0313	0.676***	0.108	-0.0656	-0.183	0.787***
	(0.382)	(0.206)	(0.182)	(0.151)	(0.314)	(0.193)
Observations	210	169	193	152	197	156
R-squared	0.371	0.252	0.255	0.224	0.280	0.186
Number of Countries	22	22	22	22	22	22
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of non-oil taxes on government oil revenue for 1998-2012 in 22 oil countries (countries listed in Table 1 excluding Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) controlling for service value-added, with country and year fixed effects. Oil revenue, non-oil taxes and service value-added are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table 11: Price Shock on Oil Income and Variation in Non-Oil Taxes controlling for sectorial GDP

VARIABLES	(1) Var. in Tot. Tax	(2) Var. in Tot. Tax	(3) Var. in Direct Tax	(4) Var. in Direct Tax	(5) Var. in Indirect Tax	(6) Var. in Indirect Tax
Price Shock on Oil Income	0.0177	0.0228	-0.00389	0.00314	0.0196	0.0196
	(0.0148)	(0.0154)	(0.00629)	(0.00728)	(0.0161)	(0.0202)
Lag of Price Shock on Oil Income		0.00387		0.0130		0.00204
		(0.00893)		(0.00965)		(0.0117)
Var. in Serv VA	0.143***	0.125***	0.0517***	0.0570***	0.0647**	0.0302
	(0.0248)	(0.0248)	(0.0147)	(0.0171)	(0.0262)	(0.0211)
Lag of Var. in Serv VA		0.000967		-0.0142**		0.0103
		(0.0130)		(0.00576)		(0.00601)
Constant	-0.430	0.504*	0.0724	-0.240	-0.635*	0.717***
	(0.404)	(0.244)	(0.152)	(0.145)	(0.366)	(0.193)
Observations	234	191	217	174	222	178
R-squared	0.330	0.219	0.249	0.234	0.295	0.161
Number of Countries	22	22	22	22	22	22
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Regression of non-oil taxes on price shock on oil income for 1998-2012 in 22 oil countries (countries listed in Table 1 excluding Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) controlling for service value-added, with country and year fixed effects. Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. Non-oil taxes and service value-added are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

4 Comparative Case Studies: Government Revenues in six Oil Producers

To analyze the impact of a shock on oil quantities on government revenues, we select six countries for which we have data before and after the beginning of oil production: Belize (2005), Chad (2003), Equatorial Guinea (1993), Sudan (1992),[32] Timor-Leste (2004), and Vietnam (1989).[33] In most of the graphical evidence displayed below, we analyze these countries at the same age of oil production, to make them more comparable.[34] We set t=1 in the year when oil production begins.

4.1 Countries' Oil Producer Profiles

Figure 2 shows the level of oil income generated annually in each country, plotted over the production time span (left panel) and over calendar years (right panel). Vietnam is the largest historical producer: 105 billion USD[35] of income are generated by the sector over the whole time span of production. Vietnam produces both oil and gas, mostly from the Cuu Long and Nam Con Son offshore basins. A refinery is in activity since 2009. In Sudan, 96 billion USD of oil income are generated between 1992 and 2010, mostly from the Muglad and Melut (onshore) basins. A refinery is in activity since 2002. In Equatorial Guinea, the offshore oil and gas fields (Niger delta, Douala basin) generated 84 billion USD since 1993. Gas is transformed in a Liquefied Natural Gas plant before being exported. Chad produces crude oil from the Lake Chad basin, exported via the Chad-Cameroon pipeline. A refinery started its activities in 2011. Because production starts during the oil price boom, after 11 years (by 2013) 30 billion USD of oil income have already been generated, while the same cumulated income is reached only after 15-16 years in Vietnam, Sudan and Equatorial Guinea. Oil income also soars very rapidly in Timor-Leste: 17 billion USD are generated by the offshore fields in 9 years, while it takes 14 years for Vietnam, Sudan and Equatorial Guinea to reach the same level. Belize is still a small producer, only 603 million USD are generated since 2005. In fact, it is only because of the unusually high prices of the 2000s that the relatively small proved reserves began being extracted (Fineberg 2011).[36] In the right panel of Figure 2, the sharp drop in oil income due to the 2009 drop in prices is clearly visible for all countries.[37]

Figures 3 to 8 display for each country the sharp rise in oil income when production starts, as well as oil revenue, non-oil taxes, and total revenues, all expressed as a share of GDP (left panels). In Belize, the average share of oil in GDP is of only 6.8% over the period. Chad's GDP at the eve of oil production is 4.2 billion USD, by t=3, oil already accounts for 53% of GDP, and subsequently remains between 30 and 50% of GDP. Timor-Leste's initial GDP is only 509 million USD, oil accounts for 67% of GDP as soon as in year t=1. Equatorial Guinea appears as the country with the most oil-dominated economy: initial GDP is 197 million USD, oil's average share in the economy over the period is 91%. Because of their larger initial economies, oil accounts for a smaller share of GDP in Sudan and Vietnam, although they are larger producers in terms of

[32] We study Sudan until 2011 only, which is when South Sudan - where most of the oil fields are - became independent.

[33] Oil production actually starts in 1986 in Vietnam, but the tax data is not comparable before and after 1988 (Prichard et al. 2014). That is why we choose 1989 as the first year of production (oil income is inferior to 1% of GDP before 1989).

[34] Although it is also important to take stock of the differences in the oil production environment across calendar years, notably the price level.

[35] All values are given in constant 2000 USD.

[36] All the references in this Section are listed in the country specific sources in Table A9 in the Appendix.

[37] It is visible for Belize at a smaller scale.

income generated: the share of oil in GDP never exceeds 31% in Sudan and 16% Vietnam. There are strong data limitations for the study of Equatorial Guinea: for some years, oil income exceeds GDP, leading to (erroneous) negative non-oil GDP values.[38] In the subsequent analysis, we delete years with negative non-oil GDP values, as well as years with implausibly high values of the non-oil tax to non-oil GDP ratio.[39] Results for this country are only indicative and must be treated with caution.

[38]This problem is not specific to our data: resource rents from the WDI are not available for the same years, since the World Bank deemed they were implausibly high (2016 communication with World Bank Data helpdesk).

[39]We delete observations where non-oil taxes exceed 30% of non-oil GDP.

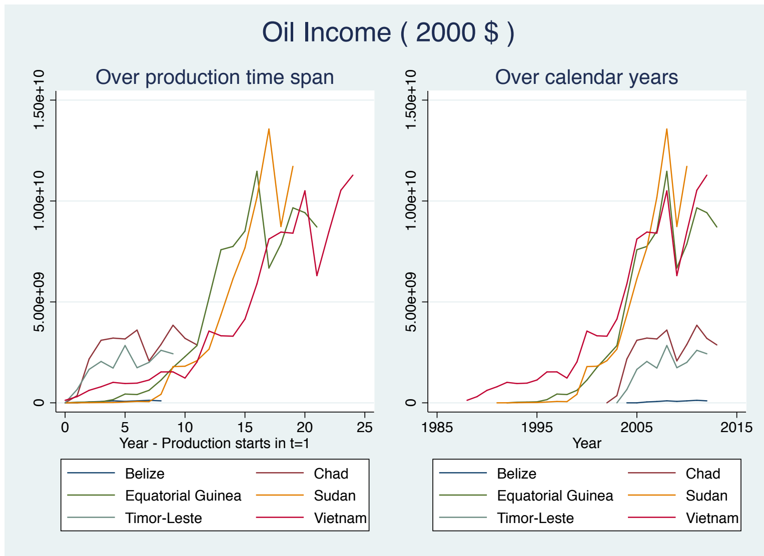

Figure 2: Oil Income in constant 2000 USD over time in Belize, Chad, Equatorial Guinea, Sudan, Timor-Leste and Vietnam

Note: Oil income is oil and gas production multiplied by international prices (source: Mahdavi and Ross Oil and Gas Dataset). In the left panel it is plotted over years since the beginning of production, in the right panel over calendar years.

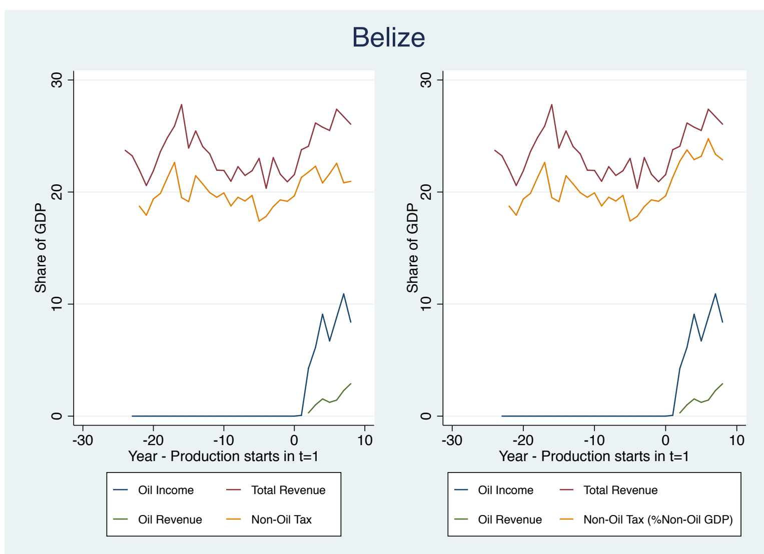

Figure 3: Oil Income and Government Revenues in Belize

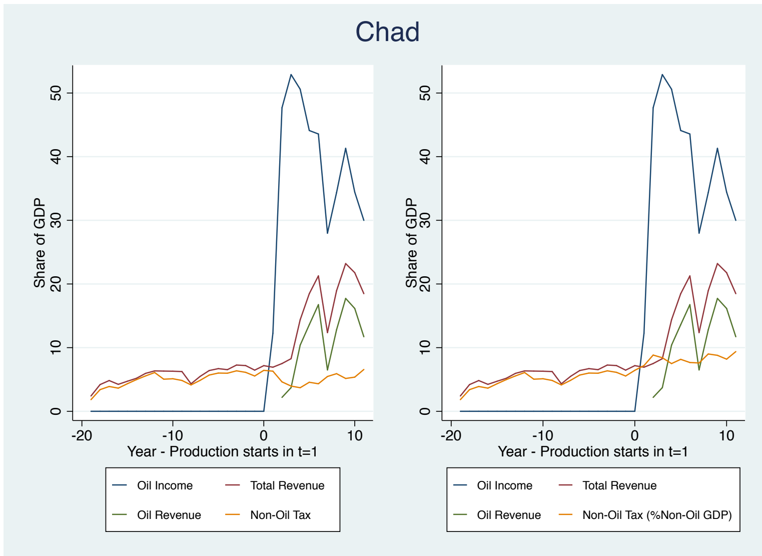

Figure 4: Oil Income and Government Revenues in Chad

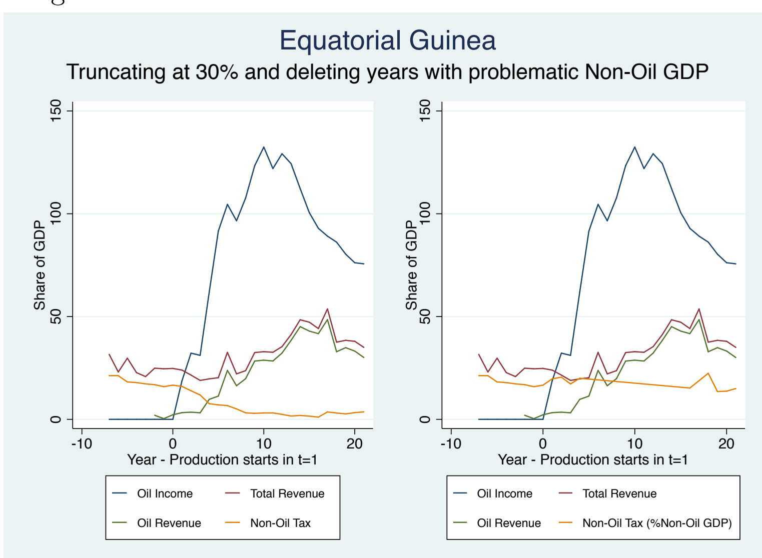

Figure 5: Oil Income and Government Revenues in Equatorial Guinea

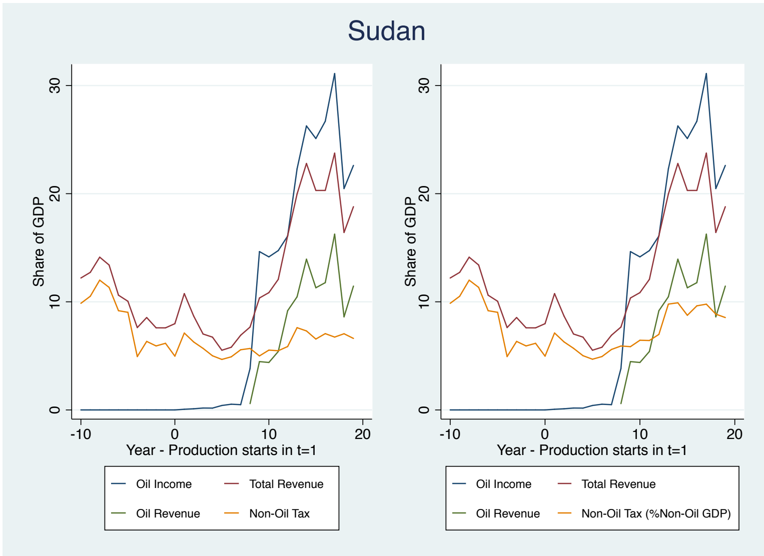

Figure 6: Oil Income and Government Revenues in Sudan

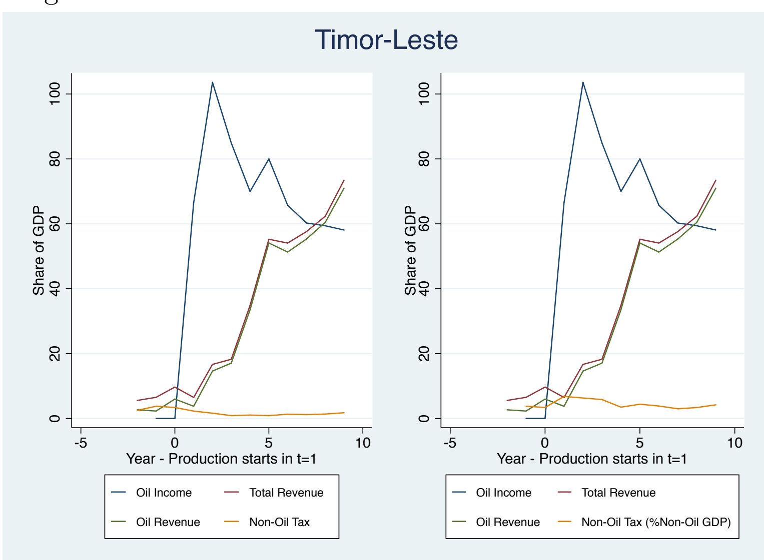

Figure 7: Oil Income and Government Revenues in Timor-Leste

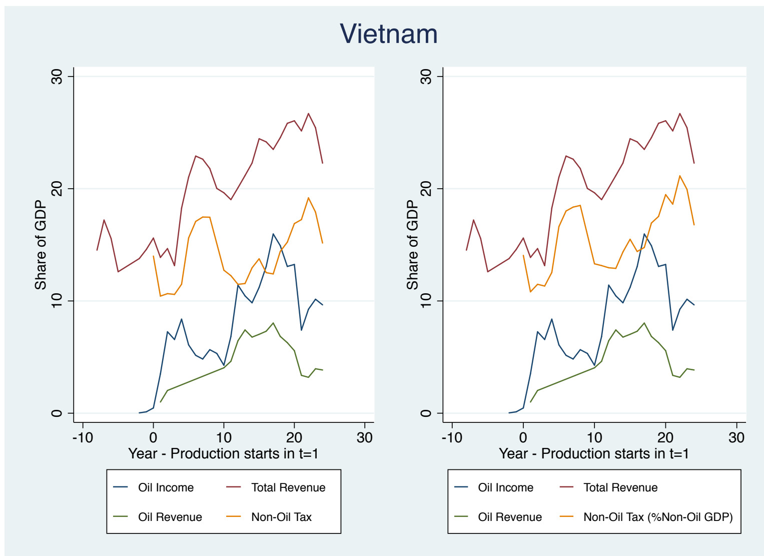

Figure 8: Oil Income and Government Revenues in Vietnam

Note for Figures 3 to 8: Oil income is oil and gas production multiplied by international prices (source: Mahdavi and Ross Oil and Gas Dataset). Total revenues are all government revenues (excluding social contributions), oil revenue is total resource revenue, and non-oil tax are non-resource taxes (source: ICTD GRD). Non-oil tax is computed as a share of GDP in the left panel, and as a share of non-oil GDP (GDP minus oil income) in the right panel. All other variables are expressed as a share of GDP. t=1 is the year in which production starts: 2005 for Belize, 2003 for Chad, 1993 for Equatorial Guinea, 1992 for Sudan, 2004 for Timor-Leste, and 1989 for Vietnam. For Equatorial Guinea: we delete years with negative non-oil GDP values, as well as years where non-oil taxes exceed 30% of non-oil GDP.

4.2 Sector Design, Fiscal Setting and Differences in the Effective Tax Rates

We describe features of each country's oil sector which can contribute to the differences observed in the effective tax rates. Figure 9 shows the effective tax rates over production time span (left panel) and over calendar years (right panel). Table 12 shows the average effective tax rate by country over the whole production period. Figures 10 to 12 show, for countries where it is available, the breakdown of oil revenue into oil taxes (mostly corporate income tax and tax on windfall profits) and oil non-tax revenues (mostly royalties and production sharing).

Belize displays the lowest average effective tax rate (18.57%), although the levels are similar to what was observed in Equatorial Guinea in the early years of production (Figure 9, left panel). Belize Natural Energy is the only producing operator. The low effective tax rate can be explained by several factors: Majors had been exploring for many years with no viable discoveries, and the reserves that have been found are relatively small, which may have reduced the government's bargaining power. As a result, the fiscal terms are deemed "extremely favorable to contractors", as illustrated by the production sharing percentage of 1.5%, allowing the contractor "to retain almost all of the production revenue" (Fineberg 2011, p.21). Additionally, the contracts allow companies to recover all of their costs before production sharing begins, meaning that the government's share is deferred to later years, leading to a situation where: "the industry take, or share of net revenue, is highly front-end loaded" (Fineberg 2011, p.10).

Equatorial Guinea's effective tax rate has a quite sluggish evolution in first years of production, taking 14 years to reach 40%. The sector is dominated by non-major foreign companies: Marathon, Noble Energy and Hess, and ExxonMobil, the only Major operating in the country. There is no State participation until 1998, and it does not exceed 5% in its first years. Fiscal terms are initially very favorable to international companies: "oil companies received by far the most generous tax and profit sharing packages in the region" (IMF 1999, cited in McSherry 2006, p.26). In addition to the low *statutory* rates, Equatorial Guinea's particularly poor governance record makes the context highly favorable to the diversion of oil revenue, through corruption, embezzlement and tax evasion. Transparency International ranked it among the 1% most corrupt countries in 2010, and ever since 2008, it has failed to meet the Extractive Industries Transparency Initiative membership requirements. The country is often cited as an epitome of the political-resource curse.[40] Directly related to our focus is the Riggs Bank corruption scandal: in 2004, accounts on which the President's family received payments from ExxonMobil and Hess since 1995 are discovered in this Washington-based bank. This directly affects our effective tax variable, at their peak, these accounts held 700 million USD, a sum amounting to just less than 20% of the total reported oil revenue over the 1995-2004 period (3.7 billion USD).[41] These accounts are closed in 2004, which of course does not mean that corruption stops nor that new schemes are not put in place An audit of international oil companies carried out in 2003 for the 1996-2001 period concluded that 88 million USD of unpaid taxes were due to the government, corresponding to 3.5% of 2003 GDP and 4% of total oil revenue received during the period covered by the audit (IMF 2003, calculations using our data). Figure 11 shows that the largest share of oil revenue comes in non-tax revenue, in this case profit sharing. We observe that the effective tax rate increases steadily in the last years of the period. Profit sharing and royalty rates both increase with quantities produced in Equatorial Guinea. Yet, quantities reach a peak in 2004 (t=12) and start declining after that, so the observed increase cannot be explained by this mechanism. The payments triggered in 2003 after the findings of the audit and the closing of the Riggs account in 2004 could contribute to the increase. But probably, a more

[40] "Oil rents have consolidated President Obiang's brutal, authoritarian regime and helped further criminalize one of the worlds most criminal states" (McSherry 2006).

[41] In constant 2000 USD.

significant role is played by the New Hydrocarbon Law of 2006, which provides for an increase in the National Oil Company's equity, in the CIT rate, and in the minimum royalty rate, as well as a provision for the government to: i. review existing contracts, ii. impose a tax on windfall profits (IMF 2007, Republic of Equatorial Guinea 2006). This provides a perfect example of fiscal adjustments made in the 2000s to better capture the benefits of the oil price boom.

Chad, where the average effective tax rate over the period is 29.08%, is the only country under study where the fiscal regime is a tax/royalty or concession system.[42] The main operators are ExxonMobil, Petronas and Chevron, the last two joining the consortium in 2000.[43] The National Company, *Société Nationale des Hydrocarbures du Tchad* is created in 2006 and joins the consortium (Freshfields 2006). The threshold above which companies are required to pay the corporate income tax is reached in 2006 (IMF 2007), which is clearly visible in Figure 10: from 2006 onwards, oil taxes are the main source of oil revenue. Also in 2006, President Déby accuses Chevron and Petronas of not paying a portion of their tax liabilities. The settling of the dispute leads to an additional payment in the same year (*Oil and Gas Journal*, 2006). In 2009, oil revenue falls more than proportionally to oil income, since the effective tax rate drops from 38.45% to 23.23%, a much more significant drop than what is observed in the other countries (Figure 9, right panel). This suggest that the fiscal instruments existing in Chad link the effective tax rate to prices/profitability more strongly than those in place in the other countries. Like Equatorial Guinea, the opacity of Chadian institutions and of the oil sector in particular can be illustrated by the country's position at the very bottom of Transparency International's corruption ranking. Therefore it is highly likely that the government's reported revenues are inferior to what the statutory rates provide for. Furthermore, the country's exploration and production history has been marked by political tensions and war episodes. This reduces the government's bargaining power, since companies expect to be compensated for the risk they are taking by investing and operating in the country.

Like Chad, Sudan's oil history has been characterized by instability and war (with some interactions between the two countries' geopolitical turmoil). A striking illustration is the kidnapping and killing of three expatriate workers on a Chevron facility by rebel group Anyana II in Sudan in 1984. Because of this instability factor, capital investments are very low until the late 1990s, in spite of the more competitive terms offered by the government to attract investors after the onset of the civil war in the 1980s. It is only after the 1992 government offensive to chase Sudan People Liberation Army rebels from the oil rich zones that production starts, first by Romanian Rompetrol, before China National Petroleum Corporation starts its activities in the late 1990s. Petronas and India's Oil and National Gas Corporations join later, entering in Production Sharing Agreements with the National Oil Company (U.S. Energy Information Administration). Sudapet (established in 1996) remains overall a small shareholder because of its limited technical expertise and financial resources (Hansohm 2007). The average effective tax rate over the period is 42.05%. It peaks in 2003 (t=12), and is then very volatile, stagnating/declining rather than increasing in the years of the oil price boom. Production increases strongly during this period, so what we observe cannot be caused by lower rates associated to lower quantities. It seems that Sudan is emblematic of the absence of progressivity of most oil countries described in Section 2.1: the fiscal setting doesn't allow for the government to capture the benefits of an increase in oil prices (this could be combined with higher levels of corruption/embezzlement in the years of the price boom and of strong political instability).

Vietnam's average effective tax rate over the period is 51.70%, the second highest after Timor-Leste (61.02%). The National Oil Company PetroVietnam has been the dominant actor since

[42] Production Sharing Agreements were adopted but only for post-2010 contracts.

[43] CNPC is active in exploration, and in the refinery's activities.

the first offshore wells of the late 1980s, operated in a joint venture with the USSR company Vietsovpetro. Between the late 1970s and the late 1990s there has been much toing and froing in the relationships between the Vietnamese communist government and international oil companies, including for example the unilateral scrapping of all exploration contracts in 1975 and the US embargo which prevented American companies to operate in the country until 1994. The situation since the 1990s is one where PetroVietnam- directly under the authority of the Prime Minister - holds a 20-50% equity stake in all projects, and enters in Production Sharing Agreements with foreign companies, including two majors, ExxonMobil and Chevron (Petrovietnam website). Two generations of contracts exist: before 1993, the regime was one of the most lenient in the region. In 1993, the government share was increased, and royalties were introduced (Columbia Center on Sustainable Development, 2013). The fact that it is the oldest and largest producer, the richest pre-oil economy, that it has a better governance record than its Sub-Saharan counterparts, and an oil sector characterized by a strong NOC, with also some foreign companies introducing competitive pressures, are all factors which can explain Vietnam's relatively high effective tax rate in the first 15 years of production. However, the low success rates and high drilling costs led to a drop in activity between 1997 and 2000, and some companies withdrew. Therefore some incentives were introduced in the subsequent years: increase in the cost recovery cap and lower royalty rate in 2000, lower corporate income tax rate in 2004 (Columbia Center on Sustainable Development, 2013). This could explain the decrease in the effective tax rate observed from 2003 onwards. Another factor could be the decline in quantities after 2004, since both the pre- and the post-1993 contracts provide for government shares that vary with quantities. By the end of the period, the effective tax rate is lower in Vietnam than in Chad and Equatorial Guinea. The sector is not exempt from corruption, as illustrated by the 2003 and 2004 scandals,[44], yet, contrasting Vietnam's general governance profile to those of Chad, Equatorial Guinea and Sudan places it in a favorable position.

Several factors can contribute in explaining the impressive level and growth of the effective tax rate in Timor-Leste. The main producer is Conoco-Phillips, which in 2012 accounts for over 50% of the oil revenue accruing to the government (Natural Resource Governance Institute Country Profile). Timor-Leste's producer profile is close to Chad's: both countries start production at around the same time, and the oil income generated has the same magnitude (Figure 2). However, Timor-Leste has done a "better job" in negotiating contracts adapted to a decade of exceptionally high prices: from the start, the contracts included a supplemental petroleum tax and an additional profits tax (Deloitte 2015): "this high degree of sensitivity reflects a regime in which the average effective tax rate for Bayu-Undan rises with intrinsic profitability" (IMF 2009, p.12). At the same time we see that the government's share is not very affected by the 2009 drop in prices: the setting allows the government to benefit from high prices without being too exposed to price volatility. Maybe the fact that the United Nations Transition Administration in Timor-Leste (UNTAET) was responsible for renegotiating all oil contracts on behalf of the government in the early 2000s, just after Timor-Leste's independence from Indonesia, contributed to the establishment of these favorable terms. All the oil revenue goes in a dedicated fund, a mechanism which supposedly limits embezzlement, and more generally, Timor-Leste ranks particularly high on the Revenue Watch Index 2010 (which measures government disclosure practices in the extractive sector). It also met the EITI requirements as soon as 2010, although Chad, which had applied in 2007, became a member in 2014 only. The discrepancy between theoretical revenues as defined by the fiscal legislation and the actual revenues entering the government's budget is therefore probably smaller

[44]In 2003, the Prime Minister dismissed the general director of the company Nguyen Xuan Nham on alleged corruption, and in the 2004, the names of a dozen of PetroVietnam and government officials having received illegal payments form a contract with a fake subsidiary were disclosed, and one of the five deputy general directors of the national company was arrested.

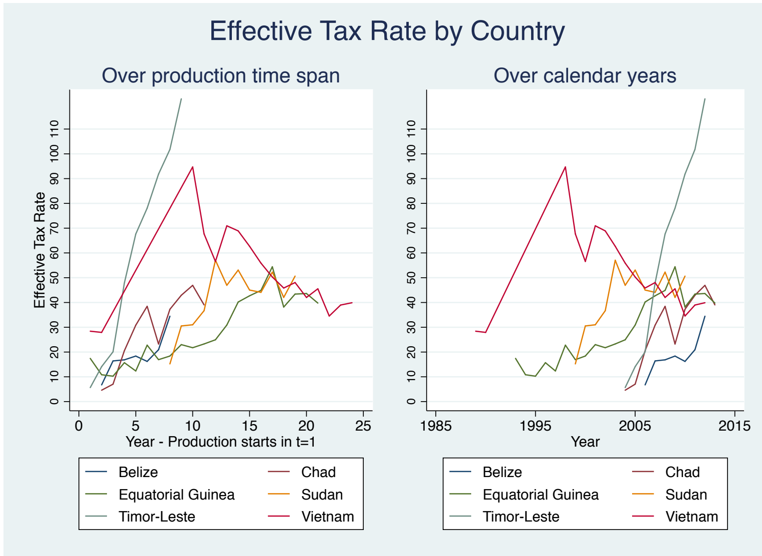

Figure 9: Effective Tax Rate over time in Belize, Chad, Equatorial Guinea, Sudan, Timor-Leste and Vietnam

Note: The effective tax rate is calculated as the ratio of total resource revenues (source: ICTD GRD) to oil and gas income (source: Ross-Mahdavi Oil and Gas Dataset). In the left panel it is plotted over years since the beginning of production, in the right panel over calendar years.

in Timor-Leste than in Chad. Finally, we observe that the effective tax rate is higher than 100% for the last years of the period. This could be because the government's share is front-loaded. Overdue taxes collected by the government in 2011 and 2012, which allegedly should have been paid by the companies in the previous years, could also be contributing to these exceptionally high values (Lao Hamutuk 2015, p.3).

The fact that the countries displaying the highest effective tax rates over the period are countries where the main operator is either a NOC (Vietnam) or a non-Major private company (Timor-Leste) and where production is offshore are in line with our findings from Section 2.4.

4.3 Comparison of the Impact of Oil Revenue on Non-Oil Taxes

We first look at how oil revenue affects the ratio of total revenues to GDP. At the eve of oil production, this ratio is of 21.56% in Belize, 7.17% in Chad, 24.76% in Equatorial Guinea, 7.98% in Sudan, 9.68% in Timor-Leste and 15.60% in Vietnam. Figure 13 plots for each country the percentage growth in total revenues, computed as:

$$\Delta TOT\_REV_t = \frac{\frac{TOT\_REV_t}{GDP_t} - \frac{TOT\_REV_0}{GDP_0}}{\frac{TOT\_REV_0}{GDP_0}} \tag{15}$$

for year t, which shows how much total revenues increased beyond the increase in GDP. This growth is most impressive in Timor-Leste: after four years only, the total revenues-to-GDP ratio has grown by 260%. In Chad, ΔTOT_REV_t reaches around 200% at t=6. For all other countries, the total revenues-to-GDP ratio does not grow by more than 45% by t=5 or t=6. In Sudan, ΔTOT_REV_t reaches around 200% only after 17 years. In Vietnam, the peak is at 83% at t=23. Total revenues

Table 12: Average Effective Tax Rate by Country

	Effective Tax Rate
Belize	18.57
Chad	29.08
Equatorial Guinea	28.36
Sudan	42.05
Timor-Leste	61.02
Vietnam	51.70

Note: The effective tax rate is calculated as the ratio of total resource revenues (source: ICTD GRD) to oil and gas income (source: Ross-Mahdavi Oil and Gas Dataset). It is averaged over each country's whole production period.

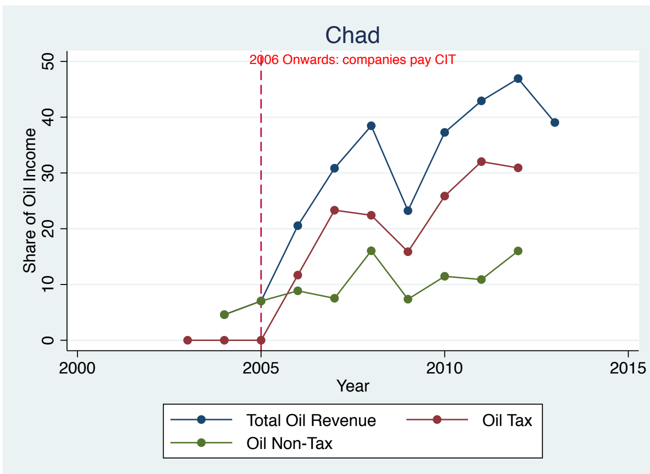

Figure 10: Breakdown of Oil Revenue in Oil Tax and Oil Non-Tax in Chad

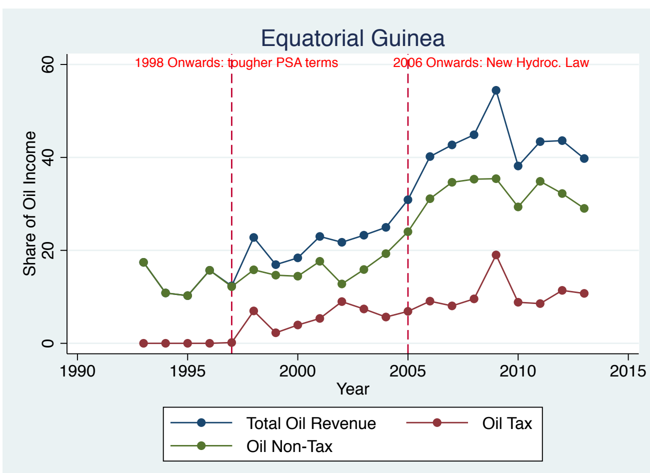

Figure 11: Breakdown of Oil Revenue in Oil Tax and Oil Non-Tax in Equatorial Guinea

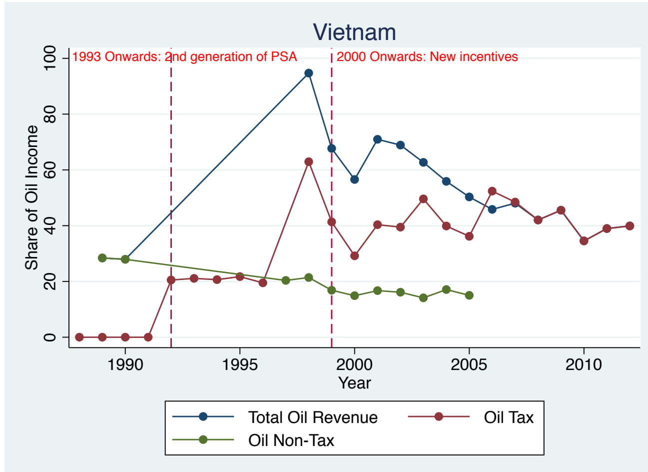

Figure 12: Breakdown of Oil Revenue in Oil Tax and Oil Non-Tax in Vietnam

Note for Figures 10 to 12: Oil revenue is total resource revenue, oil tax is resource taxes, and oil non-tax is the resource component of non-tax revenue (source: ICTD GRD). They are computed as a share of oil income (source: Ross-Mahdavi Oil and Gas Dataset). Oil revenue as a share of oil income (blue line) is the effective tax rate. The dashed red lines indicate major changes in the fiscal design of the oil sector.

grow particularly slowly in Equatorial Guinea, they even decline at the beginning of production, are doubled only after 14 years, and by the end of the period, surprisingly, they are lower than a few years before oil production begins. This shows that oil revenue is not large enough to drive the ratio of total revenues to GDP upwards, and/or that other revenues decrease or at least stagnate.

The right panel of Figure 13 shows the evolution in the weight of oil revenue in total revenues, or what is also called fiscal dependence on oil. Here again the country where oil revenue seems to have the strongest fiscal impact is Timor-Leste: starting t=2, it never represents less than 88% of total revenues. Equatorial Guinea and Chad come in second position, with an average share of oil revenue in total revenues of 64% and 63% respectively. In Sudan starting t=12, oil revenue amounts to around 50-60% of total revenues. Vietnam appears as much less fiscally dependent, oil revenue never exceeding 35% of total revenues. In Belize, it reaches 11% at the end of the period.

Next, we want to look at the evolution in total revenues and oil revenue relative to oil income generated, *controlling for the evolution in GDP*: for each additional dollar of oil income, by how much did total revenues increase, and how much were captured by the government as oil revenue? We compute the following ratios:

$$\gamma TOT\_REV_t = \frac{TOT\_REV_t - TOT\_REV_0}{OIL\_INC_t - OIL\_INC_0} \quad (16)$$

$$\gamma OIL\_REV_t = \frac{OIL\_REV_t - OIL\_REV_0}{OIL\_INC_t - OIL\_INC_0} \quad (17)$$

for t=2, 5, and 10, where all values are in constant 2000 USD. In Table 13, the ratio γTOT_REV_t is shown in the columns labeled "Tot Rev.", and the ratio γOIL_REV_t in those labeled "Oil Rev.". For Equatorial Guinea, we see that in ten years, for every dollar of oil income, 0.24 USD are collected as oil revenue, and total revenues increase by only 0.26 USD, which reveals a surprisingly small increase in non-oil revenue. A similar pattern is observed in Timor-Leste: after 5 years of of oil production, 1.05 USD are collected in oil revenue for each dollar of oil income, and total revenues increase by 1.06, suggesting that non-oil revenue is negligible. These figures hint to the possibility of an *eviction effect* in these two countries. Compared to Equatorial Guinea, after 10 years, oil revenue is of 0.33 USD in Sudan and total revenues of 0.56 USD, for each dollar of oil income. In Chad, these values are of 0.83 and 1.07 USD respectively. Finally, in Belize, after 5 years of oil production, 0.29 USD of oil revenue have been collected for each dollar of oil income, and total revenues increase by 2.43 - obviously driven by other factors than oil revenue.

The change in total revenues already gives an idea of how non-oil taxes evolve as oil revenue accrued, yet we wish to analyze more precisely the evolution in the non-oil tax ratio, to assess whether *eviction* or *synergy effects* seem to be at play. For this, in the right panel of Figures 3 to 8, non-oil taxes are plotted as a share of non-oil GDP. In Figures 14 to 17, we show, for the countries where the data allows it, the breakdown of non-oil taxes in direct and indirect taxes, both computed as a share of non-oil GDP. In Belize, we observe an increase in non-oil taxes that starts before oil revenue accrues. Looking at the breakdown into direct and indirect taxes, we see that indirect taxes increase before t=0, but that the increase in direct taxes seems contemporaneous to the opening of oil production (from 4.93% at t=0 to 8.57% of non-oil GDP at t=6). This could be due to a *synergy effect*.

In Chad, the decrease in the non-oil tax-to-GDP ratio visible in the left panel of Figure 4 is fully accounted for by the mechanical effect of the increase in GDP through oil income, since when the non-oil taxes are computed relative to non-oil GDP (right panel), they appear to be following the same trend as before oil production, from 6.4% to 9.4% eleven years later, with a steeper increase in the first years. This continuity can be attributed to improved revenue administration over the period, and to the growth of the formal sector sustained by oil-related investment, which is why they increase more sharply in the first years (IMF 2006). This is in line with the structural shift component of our *synergy effect*.

In Equatorial Guinea, problematic non-oil GDP values make it difficult to give precise figures for non-oil taxes as a share of non-oil GDP. However, Figures 5 and 15 confirm the eviction of non-oil taxes that was suggested by Table 13. From 16.63% of non-oil GDP at t=0, non-oil tax are at 11.37% by t=20.This is mainly caused by a drop in indirect taxes, from 16.14% at t=0 to around 5% at t=20.

In Sudan, there is an increase in the non-oil tax ratio in the beginning of the production period, from 4.69% in t=5 to 9.91% in t=14, which hints to a possible fiscal *synergy effect*. Subsequently, however, the ratio declines, back down to 7.2% at the end of the period, in the context of sharply rising oil prices and thus strongly increasing oil income and oil revenue. This could illustrate an *eviction effect:* in this period of optimism regarding oil revenue, less effort is made on other sources of revenues. The breakdown of non-oil taxes by fiscal instruments shows a stagnation of direct tax at very low levels (never above 2.3% of non-oil GDP), but an overall increase in indirect taxes from 3.73% to 6.56%.

In Timor, the non-oil tax ratio slightly rises in first years, but then declines, from 5.84% at t=3 to 4.21% six years later, mostly due to a decrease in indirect taxes. This illustrates a potential *eviction effect* in this country where the average non-oil tax ratio over the period is the lowest in our sample, at 4.21%. The IMF's 2007 Article IV report states that: "The increase in oil revenue enables wide-ranging tax reforms. A simplified tax regime, including a reduction in tax rates and an increase in minimum thresholds, could help to encourage the private sector", suggesting that it was advised to the government to act in a way that is in line with the *tax policy* channel of the *eviction effect*.

Finally, Vietnam displays the second highest average non-oil tax ratio after Belize (15.63%),

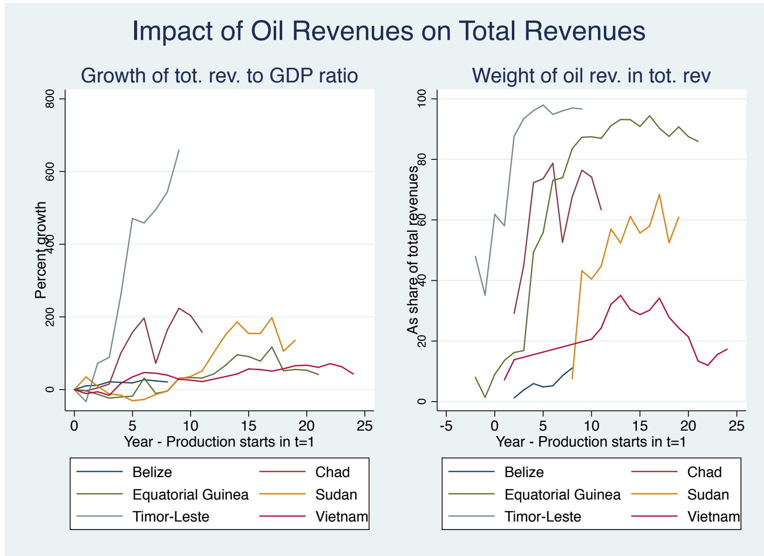

Figure 13: Impact of Oil Revenue on Total Revenues in Belize, Chad, Equatorial Guinea, Sudan, Timor-Leste and Vietnam

Note: Left panel: percentage growth of the total revenue to GDP ratio since the beginning of oil production. For each year t, the ratio ΔTOT_REV_t is the percent growth of total revenues since t=0 (equation 13). Right panel: weight of oil revenue in total revenue, computed as the ratio of oil revenue to total revenue in each year. Source: ICTD GRD. t=1 is the year in which production starts: 2005 for Belize, 2003 for Chad, 1993 for Equatorial Guinea, 1992 for Sudan, 2004 for Timor-Leste, and 1989 for Vietnam.

in spite of being the oldest oil producer. The non-oil tax ratio is marked by strong fluctuations. Oil-related investments maybe contributed to the sharp increase in the first years. The descriptive evidence doesn't hint to an *eviction effect* during the oil price boom.

Out of six countries, only two seem to display an evolution in non-oil tax which corresponds to the definition of the *eviction effect*, Equatorial Guinea and Timor-Leste. Unsurprisingly, they are also the countries where the share of oil revenue in total revenues is the highest. Equatorial Guinea had a relatively high non-oil tax ratio before oil production, contrary to the one in Timor-Leste which was particularly low. What they do have in common is that in both cases, the decline in non-oil tax is driven by a decline in indirect taxes.

Table 13: Change in Total Revenues and in Oil Revenue for each dollar of Oil Income

	Tot Rev t=2	Oil Rev t=2	Tot Rev t=5	Oil Rev t=5	Tot Rev t=10	Oil Rev t=10
Belize	2.10	0.09	2.43	0.29	-	-
Chad	0.11	0.06	0.55	0.45	1.07	0.83
Equatorial Guinea	-0.23	0.02	0.13	0.10	0.26	0.24
Sudan	-4.83	-	0.19	-	0.56	0.33
Timor-Leste	0.18	0.16	1.06	1.05	-	-
Vietnam	-2.53	0.20	0.43	-	2.80	0.94

Note: For each country, we compute the ratios $\gamma TOT\_REV_t = \frac{Tot\_Rev_t - Tot\_Rev_0}{Oil\_Inc_t - Oil\_Inc_0}$ and $\gamma OIL\_REV_t = \frac{Oil\_Rev_t - Oil\_Rev_0}{Oil\_Inc_t - Oil\_Inc_0}$ as in equations (14) and (15) , for t=2; 5; 10. All variables are in 2000 constant USD. The ratio is missing if data is missing for that year or if the country has not reached that age of production.

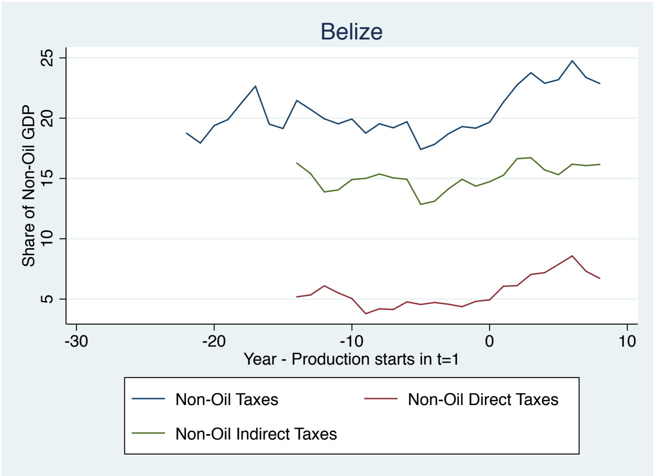

Figure 14: Breakdown of non-oil tax in non-oil direct tax and non-oil indirect tax in Belize

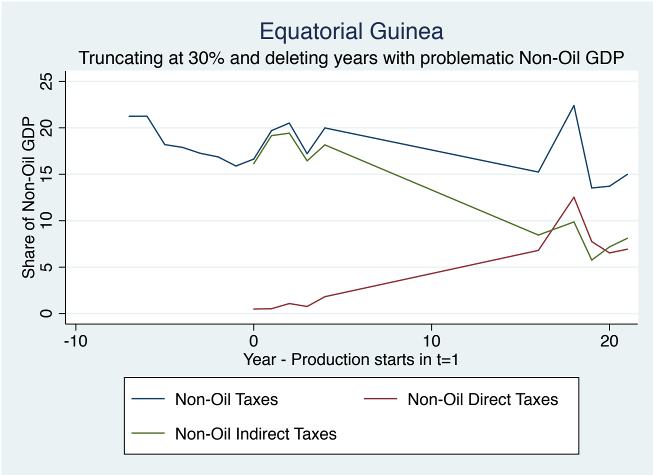

Figure 15: Breakdown of non-oil tax in non-oil direct tax and non-oil indirect tax in Equatorial Guinea

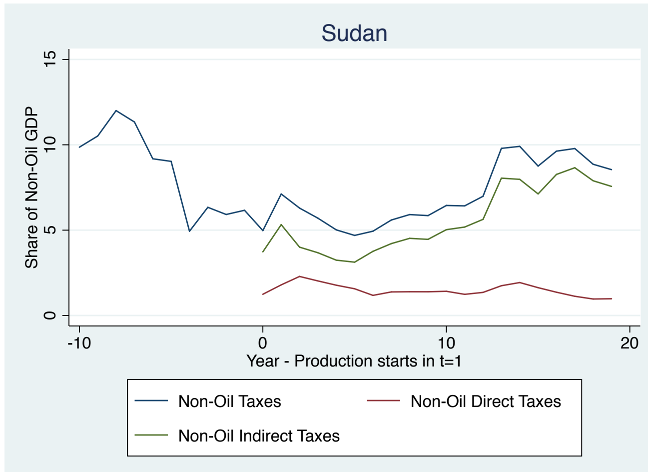

Figure 16: Breakdown of non-oil tax in non-oil direct tax and non-oil indirect tax in Sudan

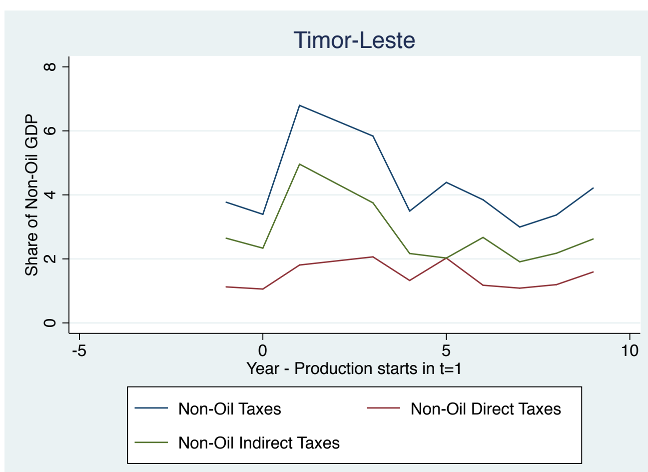

Figure 17: Breakdown of non-oil tax in non-oil direct tax and non-oil indirect tax in Timor-Leste

Note for Figures 14 to 16: Non-oil tax, non-oil direct tax and non-oil indirect tax all exclude social contributions (source: ICTD GRD). They are computed as a share of non-oil GDP: GDP minus oil income (source for oil income: Mahdavi and Ross Oil and Gas Dataset). t=1 is the year in which production starts: 2005 for Belize, 1993 for Equatorial Guinea, 1992 for Sudan, and 2004 for Timor-Leste.

5 Conclusion

Motivated by the fact that the taxation of natural resources is both crucial and particularly challenging for developing countries, this work has drawn on a unique dataset, recently made available, to produce empirical evidence on two issues pertaining to the fiscal impact of oil. Our analysis of the effective tax rate shows that for each additional dollar of oil income during the oil price boom of the 2000s, 0.30 dollars accrue to the government on average, 0.51 for each additional dollar of oil income attributable to a price shock. This share is higher in countries which are OPEC members and where some production is offshore, lower in Sub-Saharan African countries, and lower in countries which are older producers. We find that on average, the effective tax rate is not progressive with respect to prices. Our figures are still exploratory since there are still many gaps in the reporting and accounting of natural resource revenues, new developments in this domain should hopefully allow to have more reliable data.

Because of the importance of the argument according to which a decrease in non-oil taxes entailed by an increase in oil revenue is one of the causal mechanisms of the political resource curse, investigating the influence of oil revenue on non-oil taxes is the second focus of this paper. Past studies are not fully convincing once the mechanical effect on the non-oil tax-to-GDP ratio of the growth in GDP accounted for by the additional oil income is controlled for. Our findings show that during the 2000s oil price boom, oil revenue did not evict non-oil taxes. On the contrary, non-oil taxes react in a slightly positive way to variations in oil revenue. Controlling for variations in the non-oil economy leads us to conclude to the absence of a significant effect of oil revenue on non-oil tax through *taxation channels*, and to the existence of a positive effect on non-oil tax of growth in the non-oil economy very probably due to linkages with the oil sector (*structural shift effect*). Going further it would be insightful to decompose the non-oil economy in a more refined way to verify the extent to which the activities yielding additional non-oil tax are indeed linked to the oil sector.

In comparative case studies of Belize, Chad, Equatorial Guinea, Sudan, Timor-Leste and Vietnam, we look into the same issues with a different approach, referring to extensive country-specific information to account for developments in the effective tax on oil and in non-oil taxes over the whole time span of oil production. Signs of an eviction effect are observed for two countries out of six (Equatorial Guinea and Timor-Leste), confirming that the phenomenon is far from systematic.

References

Barma, N., K. Kaiser, T.M. Le, and L. Viuela (2011). *Rents to Riches? The Political Economy of Natural Resource-Led Development*. Washington: The World Bank.

Bornhorst, F., S. Gupta, and J. Thornton (2009). "Natural resource endowments and the domestic revenue effort". In: *European Journal of Political Economy* 25, pp. 439–446.

Boyce, J.K. and L. Ndikumana (2003). "Public Debts and Private Assets: Explaining Capital flight from Sub-Saharan African Countries". In: *World Development* 31 (1), pp. 107–130.

Cogneau, D. and L. Rouanet (2015). "Capital Exit from Developing Countries: Measurements and Correlates". In: PAPE Working Paper, Paris School of Economics.

Collier, P. (2010). "The Political Economy of Natural Resources". In: *Social Research* 77, pp. 1105–1132.

Crivelli, E. and S. Gupta (2014). "Resource blessing, revenue curse? Domestic revenue effort in resource-rich countries". In: *European Journal of Political Economy* 35, pp. 88–101.

International Monetary Fund (2014). "Template to collect data on government revenues from natural resources". In: URL: https://www.imf.org/external/pubs/ft/gfs/manual/pdf/templatedata.pdf.

Jensen, A. (2011). "State-Building in Resource-Rich Economies". In: *Atlantic Economic Journal* 39, pp. 171–193.

Johnston, D. (2007). "How to evaluate fiscal terms?" In: *Escaping the Resource Curse*. Ed. by M. Humphreys, J. Sachs, and J. Stiglitz. New York: Columbia University Press, pp. 56–95.

Johnston, D. and D. Johnston (2015). "Fundamental Petroleum Fiscal Considerations". In: Oxford Energy Comment, Oxford Institute for Energy Studies.

Mahdavi, P. (2014). "Why Do Leaders Nationalize the Oil Industry? The Politics of Resource Expropriation". In: *Energy Policy* 75, pp. 228–243.

Mahdavi, P. and M. Ross (2015). "Oil and Gas Data". In: Harvard Dataverse. URL: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/ZTPW0Y.

Mohtadi, P., M. Ross, and S. Ruediger (2016). "Oil, Taxation and Transparency". In: Working Paper.

Moore, B. (1966). *Social Origins of Dictatorship and Democracy. Lord and Peasant in the Making of the Modern World*. Boston: Beacon Press.

North, D. (1990). *Institutions , Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

Ossowski, R. and A. Gonzáles (2012). "Manna from heaven? The Impact of Nonrenewable Resource Revenues on Other Revenues of Resource Exporters in Latin America and the Caribbean". In: IDB Working Paper Series IDP-WP-337.

Prichard, W. (2015). *Taxation, Responsiveness and Accountability in Sub-Saharan Africa. The Dynamics of Tax Bargaining*. Cambridge: Cambridge University Press.

Prichard, W., A. Cobham, and A. Goodall (2014). "The ICTD Government Revenue Database". In: ICTD Working Paper Series WP 19.

Ross, M. (2001). "Does Oil Hinder Democracy". In: *World Politics* 53, pp. 325–361.

— (2012). *The Oil Curse: How Petroleum Wealth Shapes the Development of Nations*. Princeton: Princeton University Press.

Smith, B. (2004). "Oil Wealth and Regime Survival in the Developing World 19601999". In: *American Journal of Political Science* 48 (2), pp. 232–246.

Smith, B. and D. Waldner (2015). "Rentier States and State Transformations". In: *The Oxford Handbook of Transformations of the State*. Ed. by S. Leibfried, E. Huber, M. Lange, J. Levy, and J. Stephens. Oxford: Oxford University Press.

Thies, C. (2010). “Of rulers, rebels, and revenue: State capacity, civil war onset, and primary commodities”. In: *Journal of Peace Research* 47 (3), pp. 321–332.
Thomas, A. and J. Trevino (2013). “Resource dependence and fiscal effort in Sub-Saharan Africa”. In: IMF Working Paper Series WP13-188.
Van Meurs, P. (2008). “Maximizing the value of government revenues from upstream petroleum arrangements under high oil prices”. In: Van Meurs Corporation Discussion Document.
Vivoda, V. (2009). “Resource Nationalism, Bargaining and International Oil Companies: Challenges and Change in the New Millennium”. In:
World Bank (2015). “Building the Adjusted Net Saving Estimates: Methodology and Data”. In: World Bank Data Help Desk Documentation.

A Appendix

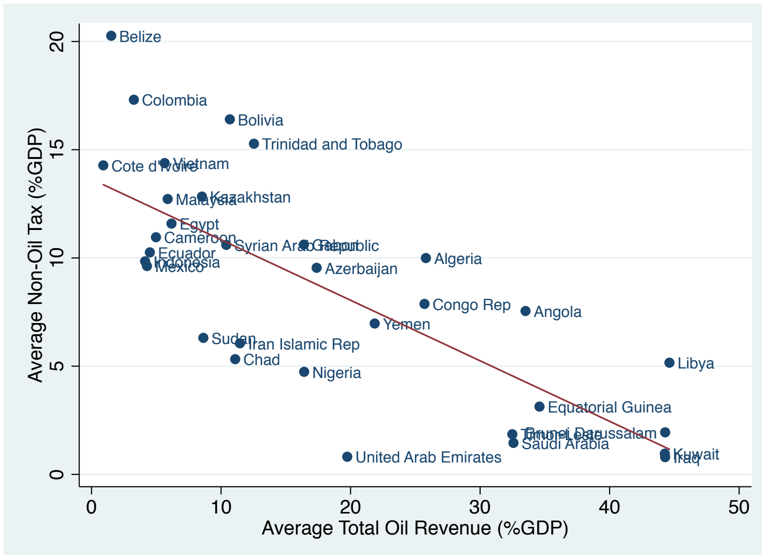

Figure A1: Country Averages of Oil Revenue and Non-Oil Tax 1998-2012

Note: Oil revenue is proxied by total resource revenues. Non-Oil Tax corresponds to all non-resource taxes excluding social contributions (source: ICTD GRD). Countries are those listed in Table A1 in the Appendix.

Table A1: Country Averages of Total Revenue and Non-Oil Tax 1998-2012

Country	Total Revenues (%GDP)	Non-Oil Tax (%GDP)
Algeria	37.16	9.99
Angola	41.50	7.55
Azerbaijan	29.01	9.54
Belize	23.86	20.26
Bolivia	28.88	16.40
Brunei Darussalam	49.70	1.94
Cameroon	16.87	10.96
Chad	12.52	5.32
Congo Rep	33.83	7.88
Cote d'Ivoire	15.89	14.28
Ecuador	16.90	10.26
Egypt	21.72	11.59
Equatorial Guinea	38.98	3.13
Gabon	28.22	10.62
Indonesia	15.63	9.84
Iran Islamic Rep	22.28	6.06
Iraq	48.64	0.80
Kazakhstan	21.09	12.83
Kuwait	60.17	0.96
Libya	53.25	5.16
Malaysia	20.64	12.72
Mexico	15.22	9.63
Saudi Arabia	38.33	1.45
Sudan	15.56	6.31
Syrian Arab Republic	25.78	10.6
Timor-Leste	34.91	1.85
Trinidad and Tobago	28.12	15.27
United Arab Emirates	27.49	0.81
Vietnam	23.35	14.38
Yemen	31.92	6.97
Average	28.57	8.71

Note: Total revenues are all government revenues excluding social contributions and grants. Non-Oil Tax corresponds to all non-resource taxes excluding social contributions (source: ICTD GRD).

Table A2: Variation in the components of Total Revenue

VARIABLES	(1) Var. in Tot. Rev	(2) Var. in Tot. Rev
Var. in Direct Tax		1.596***
		(0.444)
Var. in Indirect Tax		1.032***
		(0.114)
Var. in Oil Revenue	1.015***	1.014***
	(0.0142)	(0.0140)
Var. in Tot. Tax	1.089***	
	(0.147)	
Constant	-0.349	-0.270
	(0.439)	(0.438)
Observations	229	206
R-squared	0.976	0.973
Number of Countries	22	22
Country FE	Yes	Yes
Year FE	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of total revenue on its different components for 1998-2012 in 22 oil countries (countries listed in Table 1 excluding Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) with country and year fixed effects. All variables are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total revenue is the sum of oil revenue and total tax. Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table A3: Variation in Sectorial GDP and components of Total Revenue

VARIABLES	(1) Var. in Tot. Rev	(2) Var. in Tot. Tax	(3) Var. in Dir. Tax	(4) Var. in Indirect Tax	(5) Var. in Oil. Rev
Var. in Ind VA	0.584***	0.00483	-0.00478	0.0139	0.565***
	(0.0643)	(0.00995)	(0.00743)	(0.0125)	(0.0651)
Var. in Serv VA	-0.00484	0.143***	0.0520***	0.0611**	-0.106**
	(0.0425)	(0.0245)	(0.0147)	(0.0233)	(0.0479)
Var. in Agri VA	-0.215***	0.00496	0.00990	0.00675	-0.205**
	(0.0659)	(0.0425)	(0.0136)	(0.0375)	(0.0838)
Constant	-1.265	-0.315	0.0833	-0.562*	-0.890
	(0.795)	(0.339)	(0.150)	(0.312)	(0.932)
Observations	245	229	212	217	229
R-squared	0.731	0.330	0.242	0.292	0.739
Number of Countries	22	22	22	22	22
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of total revenue, non-oil taxes and oil revenue on sectorial value-added for 1998-2012 in 22 oil countries (countries listed in Table 1 excluding Chad, Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam), with country and year fixed effects. All variables are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total revenue is the sum of total tax and oil revenue. Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table A4: Variation in Sectorial GDP isolating Oil Income and components of Total Revenue

VARIABLES	(1) Var. in Tot. Rev	(2) Var. in Tot. Tax	(3) Var. in Dir. Tax	(4) Var. in Indirect Tax	(5) Var. in Oil. Rev
Var. in Oil Income	0.616***	-0.00439	-0.00676	0.0219	0.598***
	(0.111)	(0.0236)	(0.0185)	(0.0163)	(0.128)
Var. in Non-Oil Ind VA	0.266**	0.0532	0.0148	0.0664	0.255**
	(0.113)	(0.0374)	(0.0350)	(0.0384)	(0.104)
Var. in Serv VA	0.108	0.113***	0.0409*	0.0647***	-0.0785
	(0.0673)	(0.0273)	(0.0196)	(0.0138)	(0.0654)
Var. in Agri VA	-0.117	0.000219	-0.0257	0.0191	-0.164
	(0.153)	(0.0784)	(0.0314)	(0.0514)	(0.249)
Constant	-2.058**	-0.162	0.0887	-0.275	-1.880**
	(0.719)	(0.322)	(0.135)	(0.257)	(0.852)
Observations	142	137	132	132	121
R-squared	0.763	0.412	0.260	0.402	0.763
Number of Countries	16	16	16	16	16
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Regression of total revenue, non-oil taxes and oil revenue on sectorial value-added for 1998-2012 in 16 oil countries (Algeria, Belize, Bolivia, Brunei, Cameroon, Cote d'Ivoire, Ecuador, Gabon, Iran, Libya, Mexico, Saudi Arabia, Sudan, Syria, Trinidad, UAE), with country and year fixed effects. Industry value-added is broken down into oil income and non-oil industry value-added. All variables are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total revenue is the sum of total tax and oil revenue. Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table A5: Variation in Oil Revenue and Non-Oil Taxes controlling for sectorial GDP

VARIABLES	(1) Var. in Tot. Tax	(2) Var. in Tot. Tax	(3) Var. in Direct Tax	(4) Var. in Direct Tax	(5) Var. in Indirect Tax	(6) Var. in Indirect Tax
Var. in Oil Revenue	-0.00931	-0.0255	-0.0201	-0.0226	0.0200	-0.00470
	(0.0182)	(0.0157)	(0.0178)	(0.0259)	(0.0164)	(0.0204)
Lag of Var. in Oil Rev.		-0.00458		0.0190		-0.00234
		(0.0105)		(0.0134)		(0.0158)
Var. in Serv VA	0.106***	0.117**	0.0223	0.0425	0.0821***	0.0855**
	(0.0291)	(0.0534)	(0.0184)	(0.0293)	(0.0166)	(0.0352)
Lag of Var. in Serv VA		0.00440		0.00272		0.00533
		(0.0145)		(0.0112)		(0.0153)
Var. in Non-Oil Ind VA	0.0112	0.0180	0.0191	-0.00577	-0.00744	-0.00609
	(0.0199)	(0.0311)	(0.0187)	(0.0181)	(0.0205)	(0.0223)
Lag of Var. in Non-Oil Ind VA		-0.0249*		-0.0228		-0.00237
		(0.0120)		(0.0160)		(0.0131)
Constant	0.365	0.120	0.240	-0.385*	0.143	0.423**
	(0.342)	(0.255)	(0.154)	(0.185)	(0.288)	(0.151)
Observations	110	75	105	72	105	72
R-squared	0.391	0.405	0.254	0.324	0.359	0.340
Number of Countries	14	14	14	14	14	14
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Regression of non-oil taxes on government oil revenue for 1998-2012 in 14 oil countries (Belize, Bolivia, Brunei, Cameroon, Cote d'Ivoire, Ecuador, Gabon, Iran, Mexico, Saudi Arabia, Sudan, Syria, Trinidad, UAE) controlling for service and non-oil industry value-added, with country and year fixed effects. Oil revenue, non-oil taxes, service value-added and non-oil industry value-added are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table A6: Price Shock on Oil Income and Variation in Non-Oil Taxes controlling for sectorial GDP

VARIABLES	(1) Var. in Tot. Tax	(2) Var. in Tot. Tax	(3) Var. in Direct Tax	(4) Var. in Direct Tax	(5) Var. in Indirect Tax	(6) Var. in Indirect Tax
Price Shock on Oil Income	-0.00237	-0.0178	-0.00300	-0.0133	0.0142	0.0123
	(0.0212)	(0.0219)	(0.0114)	(0.0155)	(0.0158)	(0.0220)
Lag of Price Shock on Oil Income		-0.0109		-0.0189		-0.000725
		(0.0148)		(0.0157)		(0.0182)
Var. in Serv VA	0.0969***	0.103**	0.0217	0.0351	0.0675***	0.0614***
	(0.0281)	(0.0392)	(0.0149)	(0.0263)	(0.0188)	(0.0179)
Lag of Var. in Serv VA		-0.000429		-0.00247		-0.000147
		(0.0163)		(0.0139)		(0.0154)
Var. in Non-Oil Ind VA	0.0638	0.0561	0.0340	0.0206	0.0522	0.0510
	(0.0388)	(0.0400)	(0.0197)	(0.0206)	(0.0419)	(0.0479)
Lag of Var. in Non-Oil Ind VA		-0.0185		-0.0211		0.00819
		(0.0172)		(0.0140)		(0.00924)
Constant	-0.0178	0.144	0.184	-0.226	-0.219	0.531***
	(0.380)	(0.285)	(0.129)	(0.147)	(0.317)	(0.168)
Observations	133	95	128	92	128	92
R-squared	0.363	0.348	0.277	0.252	0.344	0.317
Number of Countries	14	14	14	14	14	14
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of non-oil taxes on price shock on oil income for 1998-2012 in 14 oil countries (Belize, Bolivia, Brunei, Cameroon, Cote d'Ivoire, Ecuador, Gabon, Iran, Mexico, Saudi Arabia, Sudan, Syria, Trinidad, UAE) controlling for service and non-oil industry value-added, with country and year fixed effects. Price shock on oil income is oil income in t-1 re-evaluated at oil price in t minus oil income in t-1, over GDP in t-1, all in t-1 USD using US GDP deflator. Non-oil taxes, service value-added and non-oil industry value-added are computed as their variation between t and t-1 over GDP in t-1 (all values in t-1 USD using US GDP deflator). Total tax is the sum of direct and indirect tax. Standard errors are clustered by country.

Table A7: Comparison with the literature: Non-Oil Taxes and the Oil Revenue-to-GDP ratio

VARIABLES	(1) Tot. Tax (%GDP)	(2) Direct Tax (%GDP)	(3) Indirect Tax (%GDP)
Oil Revenue (%GDP)	-0.0382	-0.0126	-0.0114
	(0.0424)	(0.0135)	(0.0377)
Lag of Oil Revenue (%GDP)	0.0178	0.00535	0.0193
	(0.0271)	(0.0178)	(0.0164)
Log of GDPpc	-1.963	-1.880***	-0.609
	(1.448)	(0.464)	(1.040)
State Capacity	0.704	1.345**	-0.466
	(0.821)	(0.636)	(0.641)
Agriculture	-0.0446*	-0.0104	-0.0327
	(0.0213)	(0.0114)	(0.0220)
Openness	0.00759	-0.0123**	0.0124*
	(0.0101)	(0.00559)	(0.00712)
Constant	27.18**	19.62***	11.82
	(11.42)	(3.826)	(8.168)
Observations	135	128	133
R-squared	0.230	0.362	0.228
Number of Countries	20	20	20
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of non-oil taxes on government oil revenue for 1998-2012 in 20 oil countries (countries listed in Table 1 excluding Angola, Chad, Congo Rep., Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) with country and year fixed effects. Oil revenue, total tax, direct tax and indirect tax are all computed as share of GDP. Total tax is the sum of direct and indirect tax. Oil revenue is expressed as a share of GDP. Log of GDPpc is the log of GDP per capita, State Capacity is the average of the WGI control of corruption and government effectiveness scores, Agriculture is the share of agriculture in the non-oil economy, Openness is non-oil openness to trade. All the control variables are lagged. Standard errors are clustered by country.

Table A8: Comparison with the literature: Non-Oil Taxes and the Oil Revenue-to-Non-Oil GDP ratio

VARIABLES	(1) Tot. Tax (%NOGDP)	(2) Direct Tax (%NOGDP)	(3) Indirect Tax (%NOGDP)
Oil Revenue (%GDP)	0.691	0.414	0.471
	(0.531)	(0.341)	(0.334)
Lag of Oil Revenue (%GDP)	-0.317	-0.199	-0.163
	(0.289)	(0.185)	(0.156)
Log of GDPpc	15.05	4.477	8.405
	(14.26)	(7.541)	(6.715)
State Capacity	-15.41	-4.670	-9.628
	(11.39)	(5.684)	(6.233)
Agriculture	0.160	0.00924	0.116
	(0.184)	(0.0826)	(0.132)
Openness	0.338	0.158	0.200
	(0.286)	(0.157)	(0.155)
Constant	-132.7	-41.22	-74.49
	(131.3)	(68.91)	(62.95)
Observations	135	127	132
R-squared	0.240	0.232	0.275
Number of Countries	20	20	20
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Regression of non-oil taxes on government oil revenue for 1998-2012 in 20 oil countries (countries listed in Table 1 excluding Angola, Chad, Congo Rep., Egypt, Equatorial Guinea, Indonesia, Iraq, Kuwait, Malaysia, Nigeria, Vietnam) with country and year fixed effects. Total tax, direct tax and indirect tax are all computed as share of non-oil GDP. Total tax is the sum of direct and indirect tax. Oil revenue is expressed as a share of GDP. Log of GDPpc is the log of GDP per capita, State Capacity is the average of the WGI control of corruption and government effectiveness scores, Agriculture is the share of agriculture in the non-oil economy, Openness is non-oil openness to trade. All the control variables are lagged. Standard errors are clustered by country.

Table A9: Country Specific Sources for Oil Sector Characteristics

Country	Source	Link
Algeria	Bloomberg Company Overview for BP Algeria	http://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=52138519
	"BP wins Algerian gas megadeal", Oil and Gas Journal, 12/25/1995	http://www.ogj.com/articles/print/volume-93/issue-52/in-this-issue/general-interest/watching-the-world-bp-wins-algerian-gas-megadeal.html
	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	SONATRACH website	http://www.sonatrach.com/en/elements-histoire.html
	TOTAL in Algeria website	http://www.total.dz/fr/pro/apropos-b2b.html
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis_includes/countries_long/Algeria/algeria.pdf
Angola	BP in Angola website	http://www.bp.com/en/global/corporate/about-bp/bp-worldwide/bp-in-angola.html
	CHEVRON in Angola website	http://www.chevron.com/countries/angola/
	EXXON MOBIL in Angola website	http://corporate.exxonmobil.com/en/company/worldwide-operations/locations/angola
	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	Freshfields Bruckhaus Deringer Country Profile	http://www.freshfields.com/uploadedFiles/SiteWide/News_Room/Insight/Africa_ENR /Angola/Angola%20oil%20and%20gas.pdf
	Natural Resource Governance Institute Country Profile	http://www.resourcegovernance.org/countries/africa/angola/extractive-industries
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis_includes/countries_long/Angola/angola.pdf
Azerbaijan	CHEVRON in Azerbaijan website	http://www.chevron.com/countries/azerbaijan/
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis_includes/countries_long/Azerbaijan/azerbaijan.pdf
Belize	Fineberg, B. (2011) "Belize Petroleum Economics: A Preliminary Inquiry into an Unusual Situation", Belize Coalition to Save our Natural Heritage Report	http://www.finebergresearch.com/pdf/Belizecon.pdf
	BELIZE NATURAL ENERGY website	belizenaturalenergy.bz
	IMF Article IV Reports 2008, 2013, 2014	http://www.imf.org/external/country/BLZ/
	Ministry of Energy - Geology and Petroleum Department	http://estpu.gov.bz/index.php/geology-petroleum/belize-petroleum-industry
Bolivia	"Bolivia boosts incentives for foreign oil companies", Tierraamerica Environment and Development, 02/05/2012	http://www.ipsnews.net/2012/05/bolivia-boosts-incentives-for-foreign-oil-companies/
	M.V. Vargas (2007) "Bolivia's New Contract Terms: Operating under the Nationalizatoin Regime", OGEL	http://www.kslaw.com/library/publication/mvargas_ogel_boliviancontractterms.pdf
	PETROBRAS in Bolivia website	http://www.petrobras.com/en/countries/bolivia/bolivia.htm
	TOTAL in Bolivia website	http://www.total.com/fr/en-bolivie
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=BOL
Brunei Darussalam	BRUNEI SHELL website	https://www.bsp.com.bn/main/about/history.htm
	IMF Recent Economic Developments Report 1999	https://www.imf.org/external/pubs/ft/scr/1999/cr9919.pdf
	TOTAL in Brunei website	http://www.total.com/en/brunei
Cameroon	A Barrel Full Country Profile	http://abarrelfull.wikidot.com/cameroon-oil-and-gas-profile
	Akitoby B., S. Coorey (2012) Oil Wealth in Central Africa: Policies for Inclusive Growth	https://books.google.co.ug/books?id=EQsHwbTyBrEC&pppg=RA1-PA25&lpg=RA1-PA25&dq=cameroon+new+oil+code+1999&source=bl&ots=NAAuSVclnd&sig=woOnW7hc ClgshyPcOLcTINv2PIc&hl=fr&sa=X&redir_esc=y#vv=onepage&q=cameroon%220new%20oil %20code%201999&f=fa
	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	EITI Country Profile and Country Reports	https://eiti.org/fr/cameroun
	Freshfields Bruckhaus Deringer Country Profile	http://www.freshfields.com/uploadedFiles/SiteWide/News_Room/Insight/Africa_ENR /Cameroon/Cameroon%20oil%20and%20gas.pdf
	Natural Resource Governance Institute Country Profile	http://www.resourcegovernance.org/countries/africa/cameroon/extractive-industries
	PERENCO website	http://www.perenco.com/cameroon
	TOTAL Press Release 10/11/2010	http://www.total.com/en/media/news/press-releases/total-agrees-sell-perenco-its-exploration-and-production-interest-cameroon
Chad	AfDB/OECD Report on Chadian Oil Sector	http://www.oecd.org/dev/38561813.pdf
	"Chad's Oil Revenue" ESSO	http://www.esso.com/Chad-English/PA/Files/25_ch13.pdf
	"Chevron, Petronas resolve Chad tax dispute", Oil and Gas Journal, 10/09/2006	http://www.ogj.com/articles/2006/10/chevron-petronas-resolve-chad-tax-dispute.html
	EXXON MOBIL in Chad website	http://corporate.exxonmobil.com/en/company/worldwide-operations/locations/chad
	Freshfields Bruckhaus Deringer Country Profile	http://www.freshfields.com/uploadedFiles/SiteWide/News_Room/Insight/Africa_ENR /Chad/Chad%20oil%20and%20gas.pdf
	IMF Article IV Reports 2003, 2006, 2011, 2013	http://www.imf.org/external/country/TCD/
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=TCD
Congo, Rep.	CHEVRON website	http://www.chevron.com/chevron/pressreleases/article/11011994_ chevronacquiresexplorationinterestsinrepublicofcongo.news
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=COG
Cote d'Ivoire	EITI Country Profile and Country Reports	https://eiti.org/CotedIvoire
	Norton Rose Fulbright "La lgislation ptrolire et gazire de la Cte d'Ivoire"	http://www.nortonrosefulbright.com/knowledge/publications/124020/la-legislation-petroliere-et-gaziere-de-la-cote-divoire-amont
Ecuador	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=ECU
Egypt	BP in Egypt website	http://www.bp.com/en/global/corporate/about-bp/bp-worldwide/bp-in-egypt.html
	Egypt Oil and Gas Web Portal	http://www.egyptoil-gas.com/publications/overview-of-egypts-upstream-sector/
	Iraq Oil Industry History of the Egyptian Oil Industry	http://www.iraqoilindustry.com/wp-content/uploads/2013/08/History-of-the-Egyptian-Oil-Industry.pdf
	SHELL in Egypt website	http://www.shell.com/egy/aboutshell.html
	U.S. Energy Information Administration Country Analysis	http://199.36.140.204/beta/international/analysis_includes/countries_long/Egypt/egypt.pdf

Country	Source	Link
Equatorial Guinea	AfDB/OECD Report on Equatorial Guinea's Oil Sector	http://www.oecd.org/dev/emea/40577917.pdf
	Hydrocarbons Law for the Republic of Equatorial Guinea, 2006	http://www.equatorialoil.com/PDFs%20for%20download/EG%20Hydrocarbons%20Law%20%28English%20Translation%29_v7.1.pdf
	IMF Article IV Reports 2003, 2005, 2007, 2008, 2012	https://www.imf.org/external/country/GNQ/index.htm?type=9998
	McSherry, B. (2006) "The Political Economy of Oil in Equatorial Guinea", African Studies Quarterly, Vol.8.Issue3	http://asq.africa.ufl.edu/mcsherry_spring06/
	Natural Resource Governance Institute Country Profile	http://www.resourcegovernance.org/countries/africa/equatorial-guinea/overview
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=GNQ
Gabon	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	SHELL in Gabon website	http://www.shell.com/gab/fr/aboutshell/at-a-glance.html
	TOTAL in Gabon website	http://www.total.ga/fr/lentreprise/historique
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=GAB
Indonesia	CHEVRON in Indonesia website	http://www.chevronindonesia.com/en/about/
	TOTAL in Indonesia website	http://www.total.id/en-us/total-indonesia/total-indonesia
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=IDN
Iran, Islamic Rep.	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=IRN
Iraq	BP in Iraq website	http://www.bp.com/en/global/corporate/about-bp/bp-worldwide/bp-in-iraq.html, https://eiti.org/Iraq
	TOTAL in Iraq website	http://www.total.com/fr/en-irak
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=IRQ
Kazakhstan	CHEVRON in Kazakhstan website	http://www.chevron.com/countries/kazakhstan/
	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	EITI Country Profile and Country Reports	https://eiti.org/Kazakhstan
	Olcott B. (2007) "Kazmunaigaz: Kazakhstan's National Oil and Gas Company" Rice University	http://bakerinstitute.org/media/files/page/9820ee52/noc_kaz_olcott.pdf
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=KAZ
Kuwait	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=KWT
Libya	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	Open Oil Libya Oil Almanac	http://openoil.net/wp/wp-content/uploads/2012/08/Libya-PDF-v-2.0.pdf
	TOTAL in Libya website	http://www.total.com/en/libya
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=LBY
Malaysia	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=MYS
Mexico	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=MEX
	CHEVRON in Nigeria website	http://www.chevron.com/documents/pdf/nigeriafactsheet.pdf
	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	EXXON MOBIL in Nigeria website	http://www.exxonmobil.com.ng/nigeria-english/pa/about_who_mpn.aspx
	Nigerian National Petroleum Corporation website	http://www.nnpcgroup.com/NNPCBusiness/UpstreamVentures/OilProduction.aspx
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=NGA
Saudi Arabia	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=SAU
Sudan	IMF Article IV Reports 2003, 2005, 2007, 2010	http://www.imf.org/external/country/SDN/
	Hansohm, D. (2007) "Oil and foreign aid: chances for pro-poor development in Sudan", Workshop New Growth and Poverty Alleviation Strategies for Africa	https://www.google.com/url?sa=t&rrrct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=0ahUKEwji4rumzoPLAhUFNxQKHWTkDWgQFggfMAA&url=http//%33A%2F%2Fwww.iwim.uni-bremen.de%2Fafrica%2FWorkshops%2FWorkshop2007%2FWorkshopPapers2007%2F_PPRINT %2Fdirk%252
	Natural Resource Governance Institute Country Profile	http://www.resourcegovernance.org/countries/africa/south-sudan/overview
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=SDN
Syrian Arab Republic	A Barrel Full Country Profile	http://abarrelfull.wikidot.com/syria-oil-gas-profile
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=SYR
Timor-Leste	"Timor-Leste's oil and gas are going fast" La'o Hamutuk, Timor-Leste Institute for Development Monitoring and Analysis, 15/04/2015	http://laohamutuk.blogspot.com/2015/04/timor-lestes-oil-and-gas-are-going-fast.html
	Deloitte (2015) "Oil and Gas Taxation in Timor-Leste"	https://www.google.com/url?sa=t&rrrct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwiK3JuwzIXLAhVGUhQKHboiAdUQFggkMAE&url=https//%33A%2F%2Fwww2.deloitte.com%2Fcontent%2Fdam%2FDeloitte%2Fglobal%2FDocuments%2FEnergy-and-Resources%2Fgx-er-ti
	IMF Article IV Reports 2007, 2013	http://www.imf.org/external/country/tls/
	IMF Selected Issues Report 2009	https://www.imf.org/external/pubs/ft/scr/2009/cr09220.pdf
	Natural Resource Governance Institute Country Profile	http://www.resourcegovernance.org/countries/asia-pacific/timor-leste/extractive-industries
Trinidad and Tobago	A Barrel Full Country Profile	http://abarrelfull.wikidot.com/trinidad-and-tobago-oil-and-gas-profile
	BP in Trinidad and Tobago website	http://www.bp.com/en_tt/trinidad-and-tobago/about-bp-in-trinidad-and-tobago.html
	Columbia Center on Sustainable Development (2013) Fiscal Reforms in Oil Sector Database	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=TTO
United Arab Emirates	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=ARE
Vietnam	"PetroVietnam plunges into further crisis with new corruption scandal ", Gas and Oil Connections, 06/06/2004	http://www.gasandoil.com/news/south_east_asia/931717a324956497ded9b7650ad1169b
	Fiscal Reforms in Oil Sector Database, Columbia Center on Sustainable Development	http://ccsi.columbia.edu/work/projects/fiscal-regimes-for-natural-resources/
	Natural Resource Governance Institute Country Profile	http://www.resourcegovernance.org/countries/asia-pacific/vietnam/overview
	PETROVIETNAM website	http://english.pvn.vn/?portal=news&page=detail&category_id=7&id=1057
	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=VNM
Yemen, Rep.	U.S. Energy Information Administration Country Analysis	http://www.eia.gov/beta/international/analysis.cfm?iso=YEM