



Domestic revenue displacement in resource-rich countries: What's oil money got to do with it?

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ARTICLE INFO

Keywords:

Hydrocarbon revenues
Non-hydrocarbon revenues
Institutions

ABSTRACT

Cross-country studies on the effect of hydrocarbon revenues and non-hydrocarbon tax effort are only now emerging. Using an expanded global dataset in a two-stage least squares framework, we confirm a displacement effect. A percentage point increase in hydrocarbon revenues displaces non-hydrocarbon revenues by 0.2 to 0.3 percentage points. With low levels of domestic revenue and a debt crises looming for many developing countries, resource-rich countries need to leverage on their resource wealth to invigorate the non-resource sectors of their economies. This should widen the tax base and optimize the tax take for oil-rich countries over the long haul.

1. Introduction

1.1. Overview of the "resource curse"

The concept of a "resource curse" has been discussed variously and could be broadly defined within the context of evaluating the adverse effect of natural resource wealth on development outcomes (Sachs and Warner, 1995; Collier, 2007, 2010; Collier and Goderis, 2007; Collier and Hoeffler, 2009; Badeeb et al., 2017; Yanikkaya and Turan, 2018; Mawejje, 2019; Bildirici and Gokmenoglu, 2020; Matallah, 2020). While the neo-classical or conventional view depict natural resources as input for production and therefore a potential contributor to growth and welfare improvements (Davis and Tilton, 2005), alternative views exist. For instance, the Prebisch-Singer hypothesis argues that the terms of trade for primary commodities decline over time due to their low-income elasticity of demand relative to the demand for manufactured products. More so, a natural resource-rich economy may experience a "resource pull" effect, which manifests through a 'pooling away' of physical and human resources from the non-resource sector of the economy thus depriving it the ability to expand (Klein, 2010). This invariably undermines the tax base. A shrinking of the tax base has implications for revenue mobilization in the non-resource sector when the natural resource sector diminishes or depletes over time.

1.2. Resource rents and tax revenue mobilization

A growing body of literature explore the relationship between

natural resource rents and fiscal capacity (see for example Knack, 2009; Jensen, 2011; Ossowski and Gonzales, 2012; Thomas and Treviño, 2013; Crivelli and Gupta, 2014; Mohtadi et al., 2016; Bhattacharyya et al., 2017) .¹ Knack (2009) finds that windfalls from natural resource extraction are associated with inefficient tax policy and administration. He indicates that previous studies had neither directly looked at the impact of resource windfalls on the quality of tax systems nor on taxes in manufacturing and services sectors, which mainly fall within the non-resource sector. Bornhorst, et al, (2009) break the trend using novel data which they compile on 30-oil producing countries for the period 1992 to 2005. Using panel econometric techniques, they find that among resource-rich nations, a 10 percentage point increase in hydrocarbon revenues diminishes other domestic revenue sources by as much as 2 percentage points.

For example, prior to the global financial crisis (i.e. between 1980 and 2005), natural resource revenues saw an average increase of 7.7 percentage points of GDP for resource rich countries in Sub-Saharan Africa (Keen and Mansour, 2009). On the other hand, non-resource related taxation rose by less than 1 percentage point of GDP for the same period (Keen and Mansour, 2009). The trend in tax revenue mobilization has been attributed to the increasing importance of natural resource taxation. However, compared to oil producing countries, non-oil producing countries have performed better in raising non-oil related tax revenue as a share of their Gross Domestic Product (African Development Bank, 2010). The question that arises is whether the poor performance in non-oil revenue mobilization in oil-rich countries is directly as a result of a crowding out effect of hydrocarbon revenues.

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¹ See Mawejje (2019), Nnangnon and Brun (2019), Oyarzo and Paredes (2019) and Abdulahi et al. (2019) for a survey of more recent related discussions.

In this paper, we evaluate the causal effect of hydrocarbon revenues on non-hydrocarbon tax effort using a global panel dataset. We build on [Bornhorst et al. \(2009\)](#), which is most related to our work. Our starting point is to examine the reproducibility of their main results. We do this by obtaining their data on hydrocarbon and non-hydrocarbon revenues for a global sample of 30 hydrocarbon-producing countries over the 1992–2005.

As our contribution to this literature, we expand this dataset for 77 countries over the period 1992 to 2008 by relying on the IMF's Article IV Country Review Reports for these countries. We adopt a more robust empirical strategy to address concerns about endogeneity, not adequately addressed in previous work. In evaluating the causal impact of hydrocarbon revenues on non-hydrocarbon tax effort, we construct an instrument which exploits exogenous variation in a weighted real global price of crude oil over the period. Our identification stems from the fact that the only way the weighted real global price of crude oil impacts on non-resource revenues is through its effect on resource revenues, holding other factors constant.

Furthermore, we explore the extent to which the quality of institutions mediates the relationship between hydrocarbon revenues and non-hydrocarbon revenue mobilization. We find that a 10 percentage point increase in hydrocarbon revenues as a share of GDP displaces the share of non-hydrocarbon revenues by 2 to 3 percentage points of GDP. The magnitude of the displacement effect is higher in some of our specifications, compared to [Bornhorst et al. \(2009\)](#). In effect, in the presence of oil and gas resources, revenue mobilization outside the non-resource sector diminishes. Maximizing revenue flows from newly discovered oil is important. While good quality institutions are desirable, we find their moderating influence on the adverse impact of resource revenues on non-resource revenues to be weak. The tendency of renegeing on effort to improve fiscal capacity outside the natural resource sector in the face of a boom in the latter is a concern. Sustaining a strong non-oil related revenue base is important for reducing fiscal risks but also building and maintaining the capacity of revenue management institutions. A well-diversified domestic revenue base would ensure better smoothening of tax rates over time instead of panic increases in tax rates in response to the diminishing or depletion of non-renewable natural resources.

The rest of the paper is as follows. Section two describes our empirical strategy. The results are discussed in section three. The fourth section delivers a conclusion to the study.

2. Empirical framework and description of data

As a first step, we reproduce the main specifications of [Bornhorst et al. \(2009\)](#).² Next, we expand their dataset and propose an alternative identification strategy to re-examine the evidence provided by [Bornhorst et al. \(2009\)](#). We identify and address endogeneity concerns in their paper. Furthermore, we introduce a set of omitted governance indicators such as government stability, bureaucratic quality and investor (risk) profile which could influence revenue mobilization efforts.

We follow [Bornhorst et al. \(2009\)](#), in defining hydrocarbon revenues as a percentage of GDP as our measure of natural resource dependence. This motivation is informed by our interest in re-examining the hypothesis that dependence on oil-related revenues undermines the potential for generating and sustaining non-oil revenues.

2.1. Step one: replicating [Bornhorst et al. \(2009\)](#)

The base model specification is given by the following:

$$Y_{it} = \beta_1 X_{1it} + \beta_2 X_{2it} + \phi_t + \pi_i + \varepsilon_{it} \quad (1)$$

Where Y_{it} is the main outcome (dependent) variable of interest, X_{1it} is a vector of control variables, X_{2it} is the main explanatory variable, ϕ_t is a time dummy and π_i is a country-specific fixed effect. The dependent variable is non-hydrocarbon revenues as a percentage of Gross Domestic Product (GDP) while the main explanatory variable is hydrocarbon revenues as a percentage of GDP. The list of control variables are foreign grants as a percentage of GDP, non-hydrocarbon trade openness as a percentage of GDP, agriculture (value-added) as a percentage of GDP and corruption perception index.

The basis for their choice of covariates is informed by the following. [Khattry and Rao \(2002\)](#) find that trade liberalization depresses tax revenue effort in low income countries and upper middle income countries as a result of falling incomes and trade taxes. [Gupta \(2007\)](#) notes an ambiguous relationship between trade liberalization and tax revenues although he finds a decline in revenues when trade liberalization takes the form of reduction in tariffs. [Keen and Mansour \(2009\)](#) also observe that between 1980 and 2005, trade tax revenues as a share of GDP and total tax revenue fell in Sub Saharan Africa thus presenting a major challenge for non-resource rich countries especially. [Rodrik \(1998\)](#) associates trade openness with larger role for government (fulfilled partly through increases in taxes) in providing social protection against the downside risks of running an open economy. Thus, [Bornhorst et al. \(2009\)](#) control for the level of openness with a variable they call non-hydrocarbon openness as a percentage of GDP.

[Bornhorst et al. \(2009\)](#) use GDP per capita as a proxy for the level of development in a country. The state of development of a country is likely to be correlated with the level of revenue that can be raised from both hydrocarbon investments and non-hydrocarbon investments. The structure of the economy is also relevant in determining how much revenue can be raised. [Gupta \(2007\)](#) finds that besides GDP per capita and trade openness, the share of agriculture in GDP is a strong determinant of revenue. Similarly, he finds that foreign aid has a significant impact on revenue performance. Institutional factors such as the level of corruption also affect how much revenue can be generated. Holding the level of revenue potential constant, a corrupt country is less likely to reap much benefit from its revenue potential than a less corrupt country.

In their first specification, [Bornhorst et al. \(2009\)](#) run an Ordinary Least Squares regression of non-hydrocarbon revenues as a percentage of GDP on hydrocarbon revenues as a percentage of GDP, controlling for grants as a percentage of GDP with country fixed effect and time effects in their full sample of 30 countries. In their second specification they include all other control variables. A variant of the second specification is shown in the third column of their table (see appendix), which has outliers (Russia, Kuwait and Norway) dropped out of the sample of countries used in that regression. All their panel OLS regressions have country and time fixed effects. The country fixed effect controls for time-invariant country specific factors that might be correlated with their explanatory and dependent variables while the time effects controls for factors changing in the same way over time that affect all countries and are correlated with the explanatory and dependent variables. The authors express a concern that non-hydrocarbon revenues are persistent over time and that a shock to the revenues in one period may persist and therefore affect non-hydrocarbon revenues in the subsequent year. If this concern is not accounted for in the regression, then the effect of hydrocarbon revenues on non-hydrocarbon revenues will be biased downwards. To address this, they introduce a one-year lag of non-hydrocarbon revenues as a control variable in the fourth column of their table. Doing this actually brings up the problem of auto correlation – the error term of the lagged dependent variable would be correlated with the error term of the regression. In response to this problem, the authors make use of a generalized method of moment (GMM) estimator popularly known as [Arellano and Bond \(1991\)](#) estimator. The importance of the Arellano and Bond estimator stems from its ability in

² We acknowledge the role of the authors in sharing their data on hydrocarbon and non-hydrocarbon revenues for the 30 countries they use in their sample.

helping to deal with the following.

- (i) Panel data with smaller time periods (T) and larger entities (N)
- (ii) Explanatory variables that are correlated with the error term
- (iii) Fixed effects that are contained in the error term
- (iv) Autocorrelation that arises from including a lagged dependent variable

Bornhorst et al. (2009) however provide limited information on how they specify the Arellano and Bond estimator. As a result, we attempted several specifications towards getting as close as possible to the estimates in column four of Table 3 of their paper (see appendix). For instance, they indicate that they instrument for “potentially endogenous variables, such as corruption”. In the specification we present in this paper, we use the first difference option, instrumenting both for corruption and the lagged dependent variable. The instrument for corruption is all available lag levels of the variable from t-1 and earlier while the instrument for the lag of non-hydrocarbon revenues is all available lags for the variable from t-2 and earlier.

The summary statistics we present in Table 1 is based on the base model specification in Table 3 of our results.

The average level of non-hydrocarbon revenues as a percentage of GDP is 13.5 with a standard deviation of 8.7 percentage points. Meanwhile, the average level of hydrocarbon-revenues as a percentage of GDP is 16.8 percent of GDP with a wider standard deviation of about 12 percentage points.

2.2. Step two: Re-examining the evidence from a larger sample

In the second step, we re-examine the evidence by extending the period of our sample to 2008, prior to the full pass-through effect of the global financial crises. The sample covers 77 countries. The extended sample consists of the 30 oil producing countries used in Bornhorst et al. plus 47 other countries that neighbor the former and produced insignificant (15 countries) or no oil at all (32 countries) in the year 2008. The essence is to allow for a difference-in-difference analysis, accounting for the fact that not all countries were raking in oil and gas revenues over the period under consideration.³ Data for hydrocarbon and non-hydrocarbon revenue as a percentage of GDP for the extended period was collated from the International Monetary Fund (IMF) Article IV country reports. This was complemented by domestic revenue data for non-oil producing countries from the World Bank’s World Development Indicator database and IMF’s Global Development Finance database.

As Gupta (2007) notes, countries that struggle to raise revenue from traditional sources (direct and indirect taxes) have the tendency to look

Table 1
Summary statistics for estimating Bornhorst et al. (2009).

Variable	Obs.	Mean	Std. Dev.	Min	Max
Non-hydrocarbon revenues (net of grants) as a % of GDP	298	13.5	8.7	-4.5	46.0
Hydrocarbon revenue as a % of GDP	298	16.8	11.9	0.9	67.8
Grants (net of debt relief) as a % of GDP	298	0.9	1.5	0	11.2
Corruption Perception Index	298	4.4	1.0	1.0	6.0
Log GDP per capita (2000 constant \$)	298	8.0	1.4	5.6	10.6
Non-hydrocarbon openness as % of GDP	298	63.5	35.1	15.0	181.1
Agriculture as a % of GDP	298	9.6	8.5	0.4	48.6

³ For instance, although Ghana is currently an oil producing and exporting nation, with significant revenues from the sector, it was not the case during the period under review.

to other sources such as aid and debt. Similarly, it is plausible to suggest that hydrocarbon revenues are endogenous in the model used by Bornhorst et al. (2009). Countries that have a limited tax base such as those with large informal economies or those that have an elastic tax base may face difficulties in raising non-hydrocarbon tax revenues. Furthermore, in a highly competitive world where countries try to attract foreign capital, it becomes more difficult to mobilize revenue by increasing taxes on firm-specific economic rents as compared to location-specific rents (Zodrow, 2006). One basic difference between firm-specific rent and location-specific rent is that the latter accrues to firms whose economic activity are geographically defined as in the case of mining whereas economic activities relating to the former are more geographically dispersed. Persistent difficulties and limited opportunities for mobilizing non-hydrocarbon revenues might compel countries to devote more effort into raising hydrocarbon revenues so long as that source is available. The scenario above raises the issue of reverse causality and therefore the need to instrument for hydrocarbon-revenues as a percentage of GDP.

The advantage of using commodity prices to analyze the effect of natural resources is in the fact that they are “typically unaffected by the behavior of individual countries” (Collier and Goderis, 2009).⁴ It is however important to recognize for instance that there have been situations where the supply of crude oil by a leading producer fell significantly (for example due to the unrests in Libya), which necessitated efforts by members of the Organization for Petroleum Exporting Countries (OPEC) to fill the gap in order to stabilize prices. This notwithstanding, it is reasonable to assume that the real price of crude oil is beyond the control of a single country. The expanded data allows for a treatment group (countries endowed with hydrocarbons) and control group (countries with no hydrocarbons). The proposed instrument for hydrocarbon revenues is defined as follows:

$$Instrument_{it} = P_t \times \left[\frac{Oil_{t2008}}{GDP_{t2008}} \right] \times 100\% \quad (2)$$

Where P_t is the average world price of crude oil in year t (measured in 2000 constant prices to adjust for inflation); Oil_{t2008} is total crude oil production level in barrels in year 2008 for each country and GDP_{t2008} is the 2008 GDP for each country measured in 2000 constant prices. The oil production and GDP levels are held constant over time in constructing the instrument. In this way all the independent variation in the instrument once we control for fixed effects, would be coming from factors outside the control of a country (world price of crude oil adjusted for inflation over the period under review). Thus, our exclusion restriction is that changes in the weighted real global crude oil prices only affects non-hydrocarbon revenues through its impact on hydrocarbon revenues. Oil production is not allowed to change over time since its change over time may be driven by omitted variables that are also correlated with non-hydrocarbon revenues. Interacting world oil prices with oil production splits the data between treatment and control groups. In effect, this is a difference-in-differences approach. Oil prices have a significant effect on hydrocarbon revenues for countries that have much oil and little or no effect on countries that have little or no oil.

A potential confounder to our exclusion restriction is that hydrocarbon revenues may affect non-hydrocarbon revenues through its impact on corruption, conflict or any of the possible channels of the natural resource curse. We respond to this concern by controlling for these channels using variables commonly used in the literature or their proxies. We do this both within a fixed effect econometric (FE) framework as well as employing a Generalized Method of Moments estimator (GMM). For instance, we control for corruption in our preferred specifications. We also tackle macro or political institutional concerns by accounting for proxies of conflict, war and general macroeconomic risks

⁴ They actually cite the work of Deaton and Miller (1995)..

using a set of institutional variables. A key caution, however, is that our estimates would be misleading if there are other plausible channels that have not been accounted for.

With the instrument, we run a Two-Stage Least Squares (2SLS) regression model with fixed effects. We also apply the Arellano and Bond estimator to the expanded sample, with the inclusion of the new instrument. In addition, we specify interaction terms in order to look at the differential impact of hydrocarbon revenues on countries with different governance and administration arrangements. The interaction terms include corruption, and government stability.

In alternative specifications, we drop the corruption variable since it is also part of the causal effect we are trying to estimate. In other words, corruption could be seen as one of the channels through which hydrocarbon revenues offsets non-hydrocarbon revenues. Estimates from this approach would however be misleading if reasons for corruption in a country stems from other factors other than the governance and institutional challenges oil rents bring.

The summary statistics for our extended sample in Table 2 is based on column 2 of Table 5.

There are three new variables introduced in Table 2: government stability index, bureaucratic quality index and investment profile index. These all come from the International Country Risk Group (ICRG) database. Government stability index assesses the strength of a government by giving a measure of the ability of a government to stay in office without the risk of being overthrown. The measure is scaled from 0 to 12 with zero capturing the lowest risk and 12 capturing the highest risk. There are three sub-components: government unity, popular support and legislative strength, with each scaled from 0 to 4. Bureaucratic quality measures the effectiveness of the institutions of state to carry out their mandate irrespective of changes in government. The index ranks countries from 0 to 4. Countries that score higher marks have strong institutions with effective means of maintaining the quality of their human resource base. The index on investment profile combines three sub-components, which measure risks relating to the ability of a country to enforce contracts, the extent of payment delays and the ease with which profits of foreign investors could be repatriated. The score ranges from 0 to 4. The higher the score, the higher the risks involved in investing in a country.

3. Empirical results

3.1. Results from step one

The results from attempts to replicate the main specification in Table 3 of Bornhorst et al. (2009) are shown in Table 3. Column 1 of Table 3 assesses a bivariate relationship, controlling for only grants as a share of GDP. In columns 2 to 4 we introduce the remaining set of

Table 2
Summary statistics for expanded sample with 77 countries.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Non-hydrocarbon revenues (net of grants) as a % of GDP	725	19.2	12.4	-7.4	49.7
Hydrocarbon revenue as a % of GDP	725	8.4	12.4	0	67.8
Grants (net of debt relief) as a % of GDP	725	2.2	3.8	0	27.8
Corruption Perception Index	725	3.0	1.3	0.1	6.0
Log GDP per capita (2000 constant \$)	725	8.0	1.6	5.0	10.9
Non-hydrocarbon openness as % of GDP	725	80.7	53.8	15.0	413.9
Government stability index	725	8.8	1.8	3	12
Bureaucratic Quality index	725	2.2	1.1	0	4
Investment Profile index	725	8.0	2.4	0	12
Agriculture as a % of GDP	725	12.4	11.8	0.1	62.0

Note: sample matches regression specification 2 in Table 5. Numbers converted to one decimal place.

control variables, including both country fixed effects and time effects. Coefficient estimates in columns 2 and 4 are without outliers. In column 1 of Table 3, a percentage point increase in hydrocarbon revenues is associated with a 0.16 percentage point reduction in non-hydrocarbon revenues, holding foreign grants constant. This compares with a decline of 0.19 percentage points decline in non-hydrocarbon revenues as stated in Bornhorst et al. (2009). When additional controls are introduced in column 2, a percentage point increase in hydrocarbon revenues is associated with a 0.17 percentage point decline in non-hydrocarbon revenues compared to an offset of about 0.16 percentage points in Bornhorst et al. (2009). When outliers (Russia, Kuwait and Norway) are excluded, the non-hydrocarbon revenue offset becomes 0.15 percentage points compared to 0.16 percentage points in Bornhorst et al. (2009). In the fourth column of their table of results, the authors provide limited information on how they apply the Arellano and Bond estimator. I use the first difference option and treat the lag (t-1) of non-hydrocarbon revenues as an endogenous variable. We make use of previous lags from t-2 and earlier as instruments for the lag of non-hydrocarbon revenues. Since their paper indicate that they treat the corruption variable as endogenous, we also make use of previous lags from t-1 and earlier as instruments for corruption. The rest of the explanatory variables then become my list of controls. We also control for time effects while first differencing controls for country effects.

From the results in Table 3, the coefficient on the lag of non-hydrocarbon revenue is 0.35 compared to 0.27 in Bornhorst et al. (2009). The long-run effect of a marginal increase in hydrocarbon revenue is given by the formula:

Long run effect = $\frac{\beta_1}{1-\beta_2}$; where β_1 is the coefficient on hydrocarbon revenue as a percentage of GDP and β_2 is the coefficient on the lag of non-hydrocarbon revenue as a percentage of GDP. In the long run, a one percentage point increase in hydrocarbon revenues as a percentage of GDP leads to a decline in non-hydrocarbon revenues by 0.24 percentage points of GDP compared to 0.32 percentage points in Bornhorst et al. (2009). Both are statistically significant at the 1 percent level.

On the whole, the results are comparable to Bornhorst et al. (2009). The signs, levels of significance and the coefficient on the explanatory variables are largely similar except for a few instances. The differences in those instances could be attributed to some differences in the variables used and rounding errors. For example, in Table 1, the mean values of non-hydrocarbon revenues as a percentage of GDP and non-hydrocarbon openness as a percentage of GDP are approximately 13.5 percent and 63.5 percent respectively whereas Bornhorst et al. (2009) state a value of 15 percent and 53 percent respectively. The next section looks at results from the use of the expanded sample of 77 countries (see Table 2).

3.2. Results from step two – expanded sample

Columns 1 to 6 of Table 5 present results on the expanded sample using a fixed effects estimator (i.e. columns 1 and 2), a two-stage least squares estimator (i.e. columns 3 and 4) and an Arellano and Bond estimator without and with our external instrument (i.e. column 5 and 6 respectively). In column 1, a one percentage point increase in hydrocarbon revenues is associated with a reduction in non-hydrocarbon revenues by 0.23 percentage points, holding foreign grants constant. Including the list of control variables reduces the offset in non-hydrocarbon revenues to 0.20 percentage points. In columns 3 and 4, the paper addresses the concern about the potential endogeneity of hydrocarbon revenues with an instrument. The specification also accounts for error-in-measurement bias. We define the instrument as the average real world price of crude oil weighted by the amount of oil a country had in 2008, expressed as a percentage of that country's 2008 Gross Domestic Product in year 2000 prices.

Prior to discussing the results, the next couple of paragraphs briefly look at the trend in crude oil prices, the first stage regression and the

strength of the instrument. The trend in the average world (real) price of crude oil and the nominal prices from 1992 to 2008 as shown in Fig. 1.

The real price of crude oil fluctuated in the decade between 1992 and 2002. However, after 2002 to the end period, crude oil prices were on an upward trend (see Fig. 1).

Table 4 shows the first stage regression. The first stage regression indicates a strong correlation between hydrocarbon revenue and the instrument. The test of relevance also yields an F-test value of 23.64 (against a minimum benchmark of 10) however this value reduces significantly when I allow for the clustering of standard errors by country (the F-test value of the revenue instrument reduces to 8.94). In either case the instrument remains strongly correlated with hydrocarbon revenues.

Table 4: First stage regression with instrument for hydrocarbon revenues.

Following from the first stage regression, column 3 and 4 of Table 5 provide estimates of the instrumented regression results. Its shows an offset of 0.24 percentage points in non-hydrocarbon revenues for a percentage point increase in hydrocarbon revenues. Column 5 and 6 provides Arellano and Bond estimates without and with the use of the new instrument, respectively. The result in column 6 indicate that the offset in non-hydrocarbon revenues is largely unaffected by the use of the new instrument. The offset in non-hydrocarbon revenues changes from 0.17 percentage points in column 5 to about 0.18 percentage points in column 6.

In all specifications, the effect of a percentage point increase in foreign grants, offsets non-hydrocarbon revenues by more the twice the offset caused by hydrocarbon revenues. The results seem to suggest that dependence on foreign grants is unhelpful to the effort of countries to mobilize domestic resources. There could however be the argument that the result could stem from a case of reverse causality. That is, countries that have low non-oil revenues attract foreign grants. The result nonetheless corroborates Knack (2009), who finds that foreign grants tend to reduce the incentive for countries to implement tax reforms. He also finds that this effect is even stronger than the effect of natural resource rents.

The results also indicate that countries that have a large agricultural sector face a huge hurdle as far as mobilizing domestic revenues are concerned. This result is statistically significant across all specifications and can be attributed to the highly informal and subsistent nature of the agricultural sector in many developing countries. Data is also lacking on production and consumption levels. Taxing the agricultural sector carries with it significant administrative costs in developing countries because there are so many small holders. It therefore becomes economically inefficient to incur high administrative costs to chase unpredictable revenues which are in any case transfers.

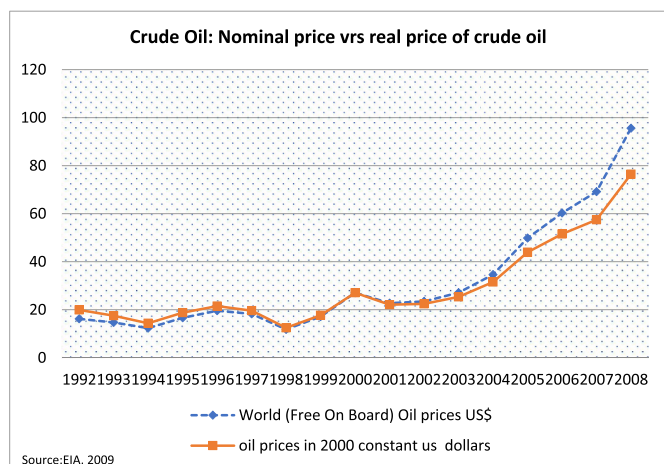


Fig. 1. Annual crude oil prices: 1992–2008.

Table 3

Replicating Bornhorst et al. (2009). We leave out alternative specifications that use hydrocarbon and non-hydrocarbon GDP as denominators for hydrocarbon and non-hydrocarbon revenues respectively. First is the challenge with data availability, accuracy and consistency. The second is the fact that they do not significantly impact the main results.

Dependent variable: non-hydrocarbon revenue as a percentage of GDP					
Independent variables	(1)	(2)	(3)	(4)	
	FE	FE	FE	GMM	
Hydrocarbon revenues as a % of GDP	-0.164*** (0.0236)	-0.169*** (0.0286)	-0.154*** (0.0270)	-0.156*** (0.0436)	
Non-hydrocarbon revenues as a % of GDP (t -1)				0.354*** (0.110)	
Grants (net of debt relief) as a % of GDP	-0.688*** (0.0488)	-1.188*** (0.116)	-1.157*** (0.114)	-1.296*** (0.170)	
Corruption Perception Index		0.307 (0.218)	0.236 (0.220)	0.117 (0.254)	
Non-hydrocarbon trade openness		-0.00786 (0.00647)	-0.00883 (0.00641)	0.0123 (0.00764)	
Ln GDP per capita in 2000 constant \$		-0.793 (0.776)	-0.0876 (0.827)	2.265 (1.820)	
Agriculture as a % of GDP		-0.173*** (0.0659)	-0.136** (0.0648)	-0.0289 (0.102)	
Observations	381	298	266	249	
Country effect	Yes	Yes	Yes	Yes	
Time effect	Yes	Yes	Yes	Yes	
Outliers excluded	No	No	Yes	No	
R-squared	0.952	0.965	0.889		
Number of countries	29	26	23	26	
Based on	Long run effect	Std. Error	P> z	[95% Interval]	Confidence
Column 4	-0.24	0.05	0.000	-0.33	- 0.15

Robust standard errors in parentheses; ***, **, * represent 1%, 5% and 10% levels of significance respectively.

Table 4

First stage regression.

Dependent variable: Hydrocarbon revenue as a % of GDP	
VARIABLES	(1)
Instrument for Hydrocarbon Revenue	0.139*** (0.0289)
Grant (net of debt relief) as a % of GDP	0.0494 (0.0587)
Corruption Perception Index	-0.393* (0.203)
Non-hydrocarbon trade openness	0.0332** (0.0131)
Log GDP per capita in 2000 constant US\$	0.307 (1.959)
Agriculture as a % of GDP	-0.0233 (0.0510)
Observations	709
Number of countries	61

Robust standard errors in parentheses ***, **, * represent 1%, 5% and 10% levels of significance respectively. With country fixed effect and time effects.

Table 5 also indicates that how open a country is with the rest of the world has a positive effect on non-hydrocarbon revenues however the effect is not statistically significant in its difference from zero. Similarly, the effect of an increase in corruption perception on non-hydrocarbon revenues is positive but statistically insignificant. In columns 5 and 6 however, the positive effect of corruption becomes statistically significant. Following Bornhorst et al., 2009, we correct for its endogeneity by

Table 5
Re-examining the evidence: results from expanded sample.

Dependent variable: non-hydrocarbon revenue as a percentage of GDP						
Independent Variables	(1) FE	(2) FE	(3) 2SLS	(4) 2SLS	(5) GMM	(6) GMM
Hydrocarbon revenues as a % of GDP	-0.233*** (0.0266)	-0.201*** (0.0272)	-0.238*** (0.0725)	-0.238* (0.122)	-0.173*** (0.0541)	-0.177*** (0.0539)
Non-hydrocarbon revenues as a % of GDP (t-1)					0.181** (0.0874)	0.179** (0.0869)
Grants (net of debt relief) as a % of GDP	-0.706*** (0.0570)	-0.839*** (0.111)	-0.842*** (0.109)	-0.842*** (0.193)	-0.594*** (0.126)	-0.598*** (0.126)
Corruption Perception Index		0.172 (0.183)	0.230 (0.199)	0.230 (0.336)	0.598** (0.247)	0.587** (0.248)
Non-hydrocarbon trade openness		0.0109 (0.00746)	0.0103 (0.00731)	0.0103 (0.0123)	0.0112 (0.00773)	0.0115 (0.00773)
Log GDP per capita in 2000 constant US\$		-0.925 (0.935)	-0.708 (1.008)	-0.708 (1.733)	1.064 (2.643)	1.020 (2.626)
Agriculture as a % of GDP		-0.219*** (0.0647)	-0.219*** (0.0638)	-0.219* (0.112)	-0.0976* (0.0591)	-0.0990* (0.0594)
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Instrumented	No	No	Yes	Yes	No	Yes
Observations	986	725	709	709	584	584
R-squared	0.922	0.948	0.245	0.245		
Number of countries	76	61	61	61	60	60

Robust standard errors in parentheses; ***, **, * represent 1%, 5% and 10% levels of significance respectively. Column 4 has robust clustered (by country) standard errors in parenthesis. Columns 5 and 6 report Arellano and Bond estimates with robust standard errors in parenthesis.

using its lagged values as instruments. The result is however contrary to what one would expect. A plausible storyline could however be that corrupt politicians care about the size of the revenue cake. The bigger the size, the bigger their share. Therein lies an implicit incentive to grow fiscal capacity.

The coefficient on the lag (t-1) of non-hydrocarbon revenues is about 0.18. Table 6 shows that, in the long-run, the effect of a percentage point increase in hydrocarbon revenues offsets non-hydrocarbon revenues by 0.21 percentage points compared to 0.24 percentage points in the 30-country sample of oil producers.

3.3. Robustness checks with alternative specifications

In Table 7, we introduce a set of institutional variables to account for their potential role in influencing non-resource revenue effort. An argument can be made that government instability in a country can discourage investment by both citizens of that country as well as foreigners. Such a situation could contribute to reducing the tax base. The level of government instability might also be correlated with the amount of hydrocarbon revenues a country would want to raise. In one instance, a country might be willing and able to raise more hydrocarbon revenues in order to appease factions or finance conflicts. In another instance, political instability might reduce a country's ability to raise hydrocarbon revenues. Nigeria offers a classic example. Conflicts in the Niger delta region, where most of the oil is produced, undermines production and therefore revenue mobilization efforts. The situation described might bias upward the estimated effect of hydrocarbon revenues on non-hydrocarbon revenues if the level of political stability is not controlled for. In column 1 of Table 7, controlling for government stability slightly reduces the offset in non-hydrocarbon revenues although the government stability variable turns out not statistically significant at conventional levels. A percentage point increase in hydrocarbon revenues is associated with a decline in non-hydrocarbon revenues by about 0.2

Table 6
Arellano-Bond estimator: Estimation of Long-run effect of hydrocarbon revenues.

Based on	Long run effect	Std. Error.	P> z	[95% Interval]	Confidence
Column 5	-0.21	0.06	0.000	-0.32	-0.10
Column 6	-0.23	0.06	0.000	-0.33	-0.11

percentage points.

Column 2 shows that the magnitude of the coefficient on hydrocarbon revenue is largely unaffected with the inclusion of bureaucratic quality. Moreover, the latter turns out statistically insignificant at conventional levels. The sign on bureaucratic quality is not typically what one would expect as it suggests that an improvement in bureaucratic quality is associated with a reduction in non-hydrocarbon revenues. However, this effect is muted due to large standard errors. Controlling for all three measures of institutional quality and stability in column 3 also leaves the coefficient on hydrocarbon revenues unchanged. The coefficient on government stability, bureaucratic quality and investment profile index are all statistically insignificant in their difference from zero.

In column 4, the study investigates whether there are differences in the levels of non-hydrocarbon revenue offset for an increase in hydrocarbon revenues in countries that have more stable governments compared to those that have no stability or are less stable governments. Thus, our interest is in the coefficient of the interaction term between hydrocarbon revenues and government stability. The evidence suggests a worse offset in non-hydrocarbon revenues for less or non-stable governments however the interaction term between hydrocarbon revenue and government stability is not statistically significant at conventional levels. Column 5 also suggests that there is no evidence of a non-linear relationship between hydrocarbon revenues and non-hydrocarbon revenues. The coefficient of the squared term of hydrocarbon revenues comes out as statistically insignificant in its difference from zero.

The grants and agriculture variables remain statistically and economically significant across all specifications. A 10 percentage point increase in share of agriculture to GDP reduces non-hydrocarbon revenues by about 2 percentage points across all specifications in Table 8. Similarly, a 10 percentage point increase in foreign grants reduces non-hydrocarbon revenues by about 8 percentage points. The coefficient on corruption perception index is statistically insignificant in its difference from zero across all specifications. In another set of specifications based on Table 8, we drop the corruption variable and find that the results are largely unaffected.

From Table 8, the interaction term between hydrocarbon revenues and corruption perception index indicates that the offset in non-hydrocarbon revenues for an increase in hydrocarbon revenues is exacerbated with increasing levels of corruption. The interaction term is however not statistically significant in its difference from zero. In column two, we introduce the instrument for hydrocarbon revenues as

Table 7
Re-examining the evidence with alternative specifications I.

Dependent variable: non-hydrocarbon revenue as a percentage of GDP					
Independent variable	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE
Hydrocarbon revenues as a % of GDP	-0.206*** (0.0507)	-0.208*** (0.0497)	-0.206*** (0.0499)	-0.292*** (0.0938)	-0.264*** (0.110)
Grants (net of debt relief) as a % of GDP	-0.839*** (0.206)	-0.837*** (0.202)	-0.840*** (0.204)	-0.827*** (0.209)	-0.840*** (0.211)
Corruption Perception Index	0.117 (0.331)	0.224 (0.347)	0.300 (0.354)	0.134 (0.335)	0.178 (0.324)
Non-hydrocarbon trade openness	0.0109 (0.0134)	0.0105 (0.0131)	0.00832 (0.0137)	0.0112 (0.0132)	0.0107 (0.0133)
Log GDP per capita in 2000 constant US \$	-1.068 (1.624)	-0.893 (1.682)	-0.531 (1.747)	-0.996 (1.574)	-0.661 (1.613)
Agriculture as a % of GDP	-0.220* (0.119)	-0.223* (0.118)	-0.226* (0.116)	-0.220* (0.119)	-0.218* (0.120)
Government stability index	0.123 (0.136)	0.0953 (0.131)	0.170 (0.132)	0.0653 (0.163)	
Bureaucratic quality index		-0.454 (0.373)	-0.252 (0.393)		
Investment profile index			-0.273 (0.168)		
Hydrocarbon revenues*Government stability (Hydrocarbon revenues) ²				0.00832 (0.00977)	0.00124 (0.00150)
Country effect	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes
Instrumented	No	No	No	No	No
Observations	725	725	725	725	725
R-squared	0.948	0.948	0.949	0.948	0.948
Number of countries	61	61	61	61	61

Robust clustered (by country) standard errors in parentheses; ***, **, * represent 1%, 5% and 10% levels of significance respectively.

Table 8
Re-examining the evidence with alternative specifications II.

Dependent variable: non-hydrocarbon revenue as a percentage of GDP				
Independent Variable	(1) FE	(2) FE	(3) GMM	(4) GMM
Hydrocarbon revenues as a % of GDP	-0.175*** (0.0685)	-0.259*** (0.127)	-0.173*** (0.0520)	-0.177*** (0.0518)
Non-hydrocarbon revenues as a % of GDP (t -1)			0.181** (0.0869)	0.179** (0.0865)
Grants (net of debt relief) as a % of GDP	-0.842*** (0.210)	-0.842*** (0.185)	-0.594*** (0.127)	-0.598*** (0.127)
Corruption Perception Index	0.243 (0.370)	0.156 (0.348)	0.596** (0.243)	0.583** (0.244)
Non-hydrocarbon trade openness	0.0116 (0.0128)	0.0103 (0.0122)	0.0111 (0.00754)	0.0114 (0.00755)
Log GDP per capita in 2000 constant US \$	-0.884 (1.611)	-0.863 (1.712)	1.125 (2.635)	1.079 (2.616)
Agriculture as a % of GDP	-0.222* (0.119)	-0.220** (0.111)	-0.0974 (0.0593)	-0.0988* (0.0596)
Government stability index		0.174 (0.126)	-0.00938 (0.151)	-0.00541 (0.150)
Hydrocarbon revenues*Corruption Perception Index	-0.0146 (0.0198)			
Country effect	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes
Instrumented	No	Yes	No	Yes
Observations	725	709	584	584
R-squared	0.948	0.245		
Number of countries	61	61	60	60

Robust clustered (by country) standard errors in parentheses; ***, **, * represent 1%, 5% and 10% levels of significance respectively. Column 3 and 4 report Arellano and Bond estimates with robust standard errors.

described in equation (2) while controlling for government stability index and find that a percentage point increase in hydrocarbon revenues offsets non-hydrocarbon revenues by approximately 0.26 percentage points.

Columns 3 and 4 then report results on Arellano and Bond estimates without and with instrumenting for hydrocarbon revenues respectively while controlling for government stability. Including government stability in the list of control variables does not change the basic results of the Arellano and Bond estimates although instrumenting for hydrocarbon revenues worsens the decline of non-hydrocarbon revenues only marginally. The long run effect of hydrocarbon revenues is identical to

the results recorded in Table 8.

The offset in non-hydrocarbon revenues for a marginal increase in hydrocarbon revenues remain statistically robust at conventional levels across all specifications.

4. Conclusion

The paper re-examines the evidence that hydrocarbon revenues offset a country's effort to mobilize non-hydrocarbon revenues. We do this by first replicating the main econometric specifications in Table 3 of Bornhorst et al. (2009). Our contribution is two-fold: we expand the data and then explore the effect of other measures of institutional quality on the relationship between hydrocarbon revenues and non-hydrocarbon revenue effort. Using an instrumental variable approach, the paper find that the non-hydrocarbon revenue offset is about 2 to 3 percent of GDP for a 10-percentage point increase in hydrocarbon revenues. Government stability, bureaucratic quality and the protection of foreign capital do not seem to significantly matter in improving non-resource revenue effort. Further work remains in this area. This includes global efforts in providing a methodologically consistent and extensive dataset on resource revenues as well as other fiscal data. With regards to the latter, database initiatives being pursued by the United Nations University's World Institute of Development Economics Research, the International Monetary Fund, among others are critical to increasing our understanding of how natural resource wealth impact on domestic revenue efforts. They would have implications for further research in this area, including providing insights into how resource-rich developing and emerging countries can leverage resource wealth to expand other sectors of the economy (and therefore the tax base) while maintaining a stable statutory tax rate.

Declaration of competing interest

None.

CRediT authorship contribution statement

Daniel Ofoe Chachu: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing - original draft, Writing - review & editing.

Acknowledgement

I would like to acknowledge Prof. Jon Bakija of Williams College, MA, USA for guidance and very valuable feedback.

APPENDIX

A. List of Countries

Algeria	Iran	Albania	Mauritius
Angola	Kazakhstan	Cape Verde	Moldova
Azerbaijan	Kuwait	Cyprus	Morocco
Bahrain	Libya	Dominican Republic	Namibia
Bahamas, The	Mexico	Fiji	Nicaragua
Bhutan	Nigeria	Finland	Panama
Burkina Faso	Norway	Ghana	Paraguay
Burundi	Oman	Greece	Portugal
Brunei	Qatar	Honduras	Senegal
Cameroon	Russia	Jamaica	Seychelles
Chad	Saudi Arabia	Kenya	Sierra Leone
Congo	Sudan	Kyrgyz Republic	Singapore
Ecuador	Syria	Latvia	Slovenia
Equatorial Guinea	Trinidad and Tobago	Lebanon	Spain
Gabon	UAE	Luxembourg	Sri Lanka
Indonesia	Venezuela	Madagascar	Switzerland
Iceland	Vietnam	Maldives	Tajikistan
Ireland	Yemen	Mali	Togo
Israel	Zambia	Malta	Uganda

B. Table 3 of Bornhorst et al., (2009) (European Journal of Political Economy)

Dependent variables	R^{NI}/Y								R^{NI}/Y^{NI}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
R^{NI}/Y	-0.1933*** (0.0373)	-0.1625*** (0.0522)	-0.1560** (0.0562)	-0.2312*** (0.0431)	-0.2268*** (0.0334)	-0.2491*** (0.0717)	-0.4275*** (0.1018)		
$(R^{NI}/Y)_{t-1}$				0.2677*** (0.0671)					
$(R^{NI}/Y)^2$						0.1812 (0.1325)			
R^{NI}/Y^* corruption							0.0536*** (0.0195)		
R^{NI}/Y interacted with									
Periods of falling revenue								-0.1613** (0.0637)	
Periods of increasing revenue								-0.1667*** (0.0572)	
R^{NI}/Y^{NI}									-0.1163*** (0.0216)
$(R^{NI}/Y^{NI})^2$									0.0414*** (0.0091)
Grants (in percent of GDP)	-0.1170 (0.1264)	-0.7465*** (0.1446)	-0.6889*** (0.1471)	-1.3785*** (0.1600)	-1.2329*** (0.2284)	-0.7396*** (0.1500)	-0.7650*** (0.1484)	-0.7446*** (0.1484)	-1.7639*** (0.3356)
Log (GDP per capita)		-0.0058 (0.0087)	-0.0018 (0.0098)	-0.0075 (0.0085)	0.0158*** (0.0057)	-0.0073 (0.0071)	-0.0096 (0.0071)	-0.0077 (0.0102)	0.0187*** (0.0070)
Non hydrocarbon openness		-0.0102 (0.0183)	-0.0128 (0.0185)	0.0254 (0.0194)	0.0258* (0.0133)	-0.0118 (0.0147)	-0.0109 (0.0145)	-0.0042 (0.0195)	0.0362*** (0.0116)
Corruption		0.0033 (0.0043)	0.0028 (0.0045)	-0.0005 (0.0032)	-0.0109*** (0.0038)	0.0035 (0.0030)	-0.0040 (0.0040)	0.0041 (0.0049)	-0.0132*** (0.0051)
Agriculture (as share of GDP)		-0.0019** (0.0009)	-0.0015 (0.0009)	-0.0011 (0.0008)	-0.0008* (0.0005)	-0.0020*** (0.0007)	-0.0017** (0.0006)	-0.0019** (0.0008)	0.0000 (0.0005)
Constant	0.1613*** (0.0063)	0.2279** (0.0910)	0.1740* (0.0975)	0.1996*** (0.0729)	0.1073** (0.0582)	0.2492*** (0.0652)	0.2960*** (0.0673)	0.2383** (0.1032)	0.1571** (0.0713)
R^2	0.21	0.26	0.30	...	0.78	0.27	0.29	0.27	0.73
F-test on equality of the coefficients								0.10	
Observations	389	290	253	244	289	290	290	268	277
Number of countries	30	25	22	25	24	25	25	25	24

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