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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/flgs20

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To cite this article: Maria Antonieta Collazos-Ortiz & Arjan H. Schakel (06 Dec 2023): Avoiding a natural resource curse? The impact of administrative efficiency on Colombian municipalities' fiscal effort, Local Government Studies, DOI: 10.1080/03003930.2023.2282565

To link to this article: https://doi.org/10.1080/03003930.2023.2282565

LOCAL GOVERNMENT STUDIES
https://doi.org/10.1080/03003930.2023.2282565

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Avoiding a natural resource curse? The impact of administrative efficiency on Colombian municipalities' fiscal effort

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ABSTRACT

The term 'paradox of the plenty' was coined to describe an often-found inverse relationship between royalty revenue and economic development. The main causal mechanism is thought to be a substitution effect whereby governments use royalty revenue to lower taxes instead of investing in activities that promote long-term economic growth. However, the occurrence of a 'natural resource curse' differs widely both for countries and subnational jurisdictions. Based on a dataset that traces 1,078 municipalities in Colombia from 2006 to 2017 and utilising a policy reform in 2012 that reduced royalty revenue for producer municipalities, we argue and find that municipal fiscal effort is higher when producer municipalities have more-efficient administrations. Our findings have important implications for the design of policy that allocates royalty revenue across subnational jurisdictions, in particular for developing countries where administrative efficiency tends to vary widely between local governments.

ARTICLE HISTORY Received 20 July 2022; Accepted 6 November 2023

KEYWORDS Natural resource curse; administrative efficiency; royalty revenue; municipalities; paradox of the plenty; fiscal effort

Introduction

Countries with many natural resources often perform worse economically than countries without any or with fewer natural resources (Sachs and Warner 1995; Van der Ploeg and Venables 2012). This finding is known as the 'natural resource curse' or the 'paradox of the plenty' because one would expect countries with natural resource abundance to economically outperform those

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/03003930.2023.2282565.

without or less access to natural resources. One of the reasons brought forward to explain this paradox is that governments tend to substitute taxation with royalty rents (Bornhorst, Gupta, and Thornton 2009; Carnicelli and Postali 2014; Crivelli and Gupta 2014) instead of investing natural resources revenue in infrastructure and human capital development that advance long-term economic growth (Badeeb, Lean, and Clark 2017; Cockx and Francken 2014). However, a 'resource curse' is not a given and various studies have found that both national and subnational governments have been able to overcome it. This raises the question: under which conditions do governments substitute tax revenue with royalty revenue?

We focus on municipal fiscal effort of 1,078 municipalities in Colombia between 2006 and 2017. A policy reform effective since 2012 significantly altered the allocation of royalty revenue in the country. Municipalities that produce natural resources saw their royalty share decline from 80% to 10% of the total amount of revenue collected by the national government, whereas non-producing municipalities experienced an increase, receiving 10% instead of 8% of the total. The 2012 reform enables us to explore whether administrative efficiency is an important enabling condition for governments to (partly) avoid off-setting taxation by natural resource revenue. We argue that the extent to which governments can and will modify their fiscal effort depends on their administrative efficiency, i.e., the extent to which municipal administrations turn inputs such as finances and personnel into policy outputs. Governments with more-efficient administrations can generate more tax revenue per percentage point tax rate than governments with low administrative efficiency. Hence, we hypothesise that producer municipalities with high administrative efficiency are more responsive to a decrease in royalty revenue and will increase their fiscal effort to a larger extent after the 2012 reform than producer municipalities with lower administrative efficiency.

The results of regression models that include fixed effects for municipalities and years and several control variables, reveal strong support for our hypotheses. Most importantly, the results reveal an important modifying role of administrative efficiency on the extent to which producer municipalities increase or decrease their fiscal effort. This result highlights the importance of institutional quality for the questions of whether and to what extent a natural resource curse occurs for subnational governments (Badeeb, Lean, and Clark 2017; Boschini, Pettersson, and Roine 2013; Bulte, Damania, and Deacon 2005; Sachs and Warner 1995). This finding is especially relevant for developing countries where administrative efficiency tends to be highly unequal across subnational jurisdictions.

In the next section, we discuss the literature that has focused on the 'paradox of the plenty' and the causal mechanism that underlies this paradox, i.e., the substitution of tax revenue with royalty revenue. In the third section,

we will outline the policy reform in Colombia implemented in 2012 and we will develop our hypotheses. Data and methods are discussed in the fourth and fifth sections and the results are presented in the sixth section. The final section concludes and discusses the implications of the results.

The 'paradox of the plenty': substitution effect between royalty revenue and taxation and the intervening role of administrative efficiency

Resource endowment can potentially be a great advantage for economic development. Countries with an abundance of natural resources can transform those natural resources into assets such as human capital, domestic private and public capital, and foreign financial assets, which foster economic development and growth (Van der Ploeg and Venables 2012). However, in practice, it appears that many resource-abundant countries are weakly economically developed. This has induced scholars to coin the terms 'the paradox of the plenty', 'resource abundance curse', and 'natural resource curse' for describing the (unanticipated) inverse relationship between natural resource endowment and economic development (Badeeb, Lean, and Clark 2017; Leibbrandt and Lynham 2018). An often-proposed causal mechanism underlying the 'paradox of the plenty' is the substitution of taxation for natural resource revenue (Bornhorst, Gupta, and Thornton 2009; Carnicelli and Postali 2014; Crivelli and Gupta 2014; Ducoing et al. 2018; James 2015).

Revenue from natural resources induce politicians to lower taxes, because this makes them more popular and increases their chances of being re-elected (Vicente 2010). Instead of investing natural resource revenue in assets that advance economic growth in the long term, such as entrepreneurism and human capital, governments decrease their fiscal effort and collect less tax revenue. Knack (2009) reveals that countries that rely heavily on royalty revenue experience a sharp deterioration in their tax administration capacity, implement extensive tax exemptions in an ad hoc manner, and apply their tax laws in a discretionary manner (see also Thomas and Trevino 2013). Thus, in the longer term, the availability of royalty revenue is likely to crowd in rent seeking, corruption, lower public health expenditures, and weak government institutions, which all negatively impact economic development (Busse and Gröning 2013; Cockx and Francken 2014; Dube and Vargas 2013; Perry and Olivera 2009).

Subnational governments can also be subject to a 'natural resource curse' (see e.g., Karl 2004). Bradford and Oates (1971) suggest that transferring an unconditional lump sum grant to a subnational jurisdiction will increase its available revenue and will create an income effect. Locally elected politicians are likely to pass on those grants to their citizens by reducing taxes and fees in an effort to increase their chances of re-election (Mogues and Benin 2012;

Vicente 2010). Hence, revenue from natural resources allocated to local governments in the form of unconditional grants are likely to decrease the incentives of receiving governments to collect local taxes (Bonet-Morón, Pérez-Valbuena, and Ricciulli-Marín 2018; Bravo 2013; Caldeira and Rota-Graziosi 2014; Masaki 2018; Melgarejo and Rabanal 2006; Mogues and Benin 2012). As a result, local governments become less accountable to their citizens, which leads to deteriorated social and economic performance. Studies that focus on subnational governments indeed find a negative impact of royalty revenue on the supply of education and health and the reduction of poverty and income inequality (Aragón and Rud 2013; Caselli and Michaels 2013; Loayza et al. 2013; Monteiro and Ferraz 2010).

A potentially important modifying factor for the occurrence of a 'paradox of plenty' is the quality of government institutions (Badeeb, Lean, and Clark 2017; Boschini, Pettersson, and Roine 2013; Cockx and Francken 2014; Mehlum, Moene, and Torvik 2006). Based on a meta-analysis of the empirical literature, Dauvin and Guerreiro (2017) point out that the quality of institutions can explain the mixed findings regarding the question of whether natural resource endowment negatively impacts economic growth.[1] This may also explain why developing countries in particular are found to be subject to a 'paradox of the plenty': most developing countries tend to have relatively weak political institutions. The impact of resource wealth on a country's incentive to mobilise non-resource domestic revenue has also received attention in the literature that explores the 'natural resource curse'. The evidence is mixed and strongly suggests that a substitution effect –i.e., a decrease in a governments' fiscal effort in response to increasing royalty revenue – depends on contextual factors such as a country's dependency on natural resource revenue, knowledge accumulation, and tax structure (Crivelli and Gupta 2014; Ducoing et al. 2018; Ossowski and Gonzáles 2012).

Research focusing on the substitution effect for local governments also presents mixed findings. Some studies find an inverse relationship between royalty revenue and fiscal effort while others do not (Badeeb, Lean, and Clark 2017; Bornhorst, Gupta, and Thornton 2009; Carnicelli and Postali 2014; Crivelli and Gupta 2014; Cust and Viale 2016; Ossowski and Gonzáles 2012; Postali 2015). The evidence is also mixed for municipalities in Colombia, which is the focus of our empirical analysis. Ramírez and Bedoya (2014) and Bonet et al. (2015) find that municipalities' effort in property tax collection declines when they become more reliant on royalty revenue, whereas Bonet-Morón et al. (2018) find that an increase in royalty revenue is positively associated with property tax collection for more-developed municipalities. We argue that these contrasting findings can (in part) be explained by differences in administrative efficiency between subnational jurisdictions. Administrative efficiency refers to the extent to which municipal administrations turn inputs such as finances and personnel into policy outputs. We focus

on administrative efficiency, because while subnational jurisdictions often increase or decrease their tax revenue by adjusting the tax rate, they can also, for example, apply exceptions granted in the law, select different collection methods, and alter penalties. The extent to which subnational jurisdictions can implement these alternative options depends not only on how much administrative *capacity* they have but also on the extent to which administrative resources are efficiently and effectively deployed. Administrative capacity focuses on financial, infrastructural, and human resources at the disposal of a government to achieve its outcomes effectively and efficiently (Christensen and Gazley 2008; De la Riva Agüero 2022).

Another important factor that determines the extent to which *subnational* governments are subject to a 'natural resource curse' is the design of the policy that allocates royalty revenue across municipalities. In most (developing) countries, natural resource revenue accrues to the national government, which subsequently distributes this revenue across subnational jurisdictions in the form of inter-governmental transfers. Ideally, inter-governmental transfers aim to support local governments in providing optimal levels of public services whereby scale effects are reaped, and externalities are internalised while subnational governments also remain accountable to their citizens (Sharma 2012). However, in practice, and especially in developing countries, royalty revenue is typically distributed to jurisdictions where the natural resources are located and is not directly aimed at reducing poverty or inequalities between local jurisdictions (Perry and Olivera 2009; Postali 2015). Also, Colombia, the focus of our empirical analysis, used to have a policy that returned the bulk of royalty revenue to municipalities where natural resources were produced. However, a recent reform drastically changed the allocation of royalty revenue, which is discussed in detail in the next section.

Fiscal effort of Colombian municipalities before and after the 2012 policy reform

There are 1,101 municipalities and 32 departments in Colombia.[2] Since a major decentralisation reform in 1991, municipalities have been responsible for the provision of public services in the areas of education, health, sanitation, and drinking water.[3] Municipal councils have been directly elected throughout the 20th century and mayors have been directly elected since 1988. Municipal revenue consists of earmarked transfers, taxes, and royalty revenue which accounted for 58.4, 12.2, and 4.5 percent, respectively, of total municipal revenue before the 2012 policy reform and account for 55.8, 13.9 and 7.3 percent after the 2012 policy reform.[4] Hence, a major revenue source for municipalities consists of royalty revenue and some municipalities have been or are heavily reliant on this source of income (the maximum score in our dataset is 87% of total municipal revenue).

The extent to which municipalities rely on royalty revenue has changed considerably because of a policy reform in 2012. Before the reform, a producer municipality –i.e., a municipality that has an oil field or a coal mine within its jurisdiction – kept 80% of the natural resource royalty revenue.[5] After the reform, the central government recentralised 50% of the royalty revenue and of the remaining 50%, half was allocated to producer municipalities. However, the share of royalty revenue allocated to producer municipalities was gradually reduced from the 25% of total royalty revenue in 2012 to 17.5% in 2013, 12.5% in 2014, and 10% from 2015 onwards (Legislative Act No 5 2011). Consequently, producer municipalities faced significant decreases in royalty revenue and had strong incentives to increase their own tax revenue in order to compensate for the lost funds.

The main tax revenue for municipalities come from a property tax (34%), a business tax (17%), and a gasoline tax (22%) (Martinez 2019). Municipalities must set the rate of the property tax within a lower and upper limit (between 0.5 and 1.6% since 2014) established by the central government (Law No 1450 2011).[6] The base and rate of the other municipal taxes are set by the central government.[7] Municipalities can increase or reduce the amount of revenue they collect by adjusting the property tax rate, but also by applying exceptions granted in the law, updating the cadaster, choosing different collection methods, and altering penalties (Bravo 2013; Law No 1450 2011; Shapiro et al. 2018).[8] The extent to which municipalities are able to collect revenue given a certain property tax rate is therefore likely to depend on their administrative efficiency.

The 2012 policy reform, which introduced a dramatic change in the incentive structure especially for producer municipalities, enables us to explore whether a substitution effect took place and whether municipal fiscal effort increased in response to decreasing royalty revenue. In addition, we can explore whether municipalities with more-efficient administrations collect more property tax revenue. These considerations lead us to develop two hypotheses:

H1: Municipalities that receive more royalty revenue will collect less property tax revenue.

H2: Municipalities with more-efficient administrations will collect more property tax revenue.

We also expect differences in fiscal effort between producer and non-producer municipalities and before and after the policy change in 2012. Available royalty revenue increased for non-producer municipalities from 8.2 to 10% of total natural resource revenue. This increase in available royalty

revenue may have created incentives for non-producer municipalities to decrease their fiscal effort after the policy reform. However, the impact is likely to be limited because 800 non-producer municipalities compete for the available royalty revenue. In stark contrast, the 278 producer municipalities that were entitled to 80% of the total natural resource revenue before the reform of 2012 saw this percentage gradually reduced to 10% from 2015 onwards. Therefore, we expect that producer municipalities in particular increased their fiscal effort after the policy reform of 2012.

H3: Producer municipalities will collect more property tax revenue after the policy reform in 2012 compared to non-producer municipalities.

In addition to, or instead of, increasing their fiscal effort, municipalities can try to increase their royalty revenue. Since the reform of 2012, municipalities have to develop project plans that must be submitted to and approved by the central government in order to receive royalty revenue.[9] The quality of the plans and the likelihood of approval of the plans by the central government are both likely to depend on the administrative efficiency of municipalities. Even though municipalities with more-efficient administrations may compensate for an anticipated revenue loss by developing high-quality plans, we expect that producer municipalities cannot avoid increasing their fiscal effort because of a stiff competition for the relatively limited available royalty revenue. We therefore hypothesise that producer municipalities with more-efficient administrations will have increased their property tax revenue.

H4: Producer municipalities with more-efficient administrations will collect more property tax revenue after the policy reform in 2012 compared to producer municipalities with less-efficient administrations.

Data

Our four hypotheses lead to three key variables of interest: fiscal effort, royalty revenue, and administrative efficiency. Fiscal effort is operationalised as the logarithm (base 10) of property tax revenue in pesos per capita in a given year. Figure 1 displays average property tax revenue collected by non-producer and producer municipalities between 2006 and 2017. Both types of municipalities increased their fiscal effort over time and producer municipalities raised, on average, more property tax revenue than non-producer municipalities. Importantly, the gap between non-producer and producer municipalities increased over time. The difference in average property tax revenue is 0.06 for 2006–2011 (4.12 compared to 4.18 log10 pesos per capita) and is 0.12 for 2012–2017 (4.29 compared to 4.41 log10 pesos per capita). This is an initial indication that producer municipalities increased their fiscal effort to

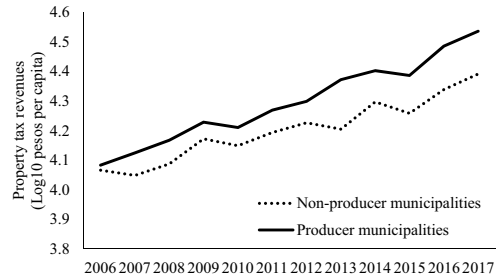

Figure 1. Property tax revenue collected by municipalities in Colombia.

a greater extent than non-producer municipalities after the policy reform in 2012 (hypothesis 3).

Royalty revenue is measured as the logarithm (base 10) of royalty revenue (in pesos) per capita received by a municipality in a given year. Figure 2 displays average royalty revenue received by non-producer and producer municipalities between 2006 and 2017. Producer municipalities received more royalty revenue over the entire period. This is not surprising, because before the policy reform in 2012 they were entitled to keep 80% of royalty revenues generated in the country. After the policy reform, as noted above, available share of total royalty revenue for producer municipalities declined from 25% in 2012 to 10% from 2015 onwards. Non-producer municipalities also receive 10% of total royalty revenue. Because the number of producer municipalities is much lower than the number of non-producer municipalities (278 versus 800), average received royalty revenue remained higher for producer municipalities. Average royalty revenue increased for both non-producer and producer municipalities, but the increase was higher for the former: 0.93 (from 1.08 in 2006 to 2.01 in 2017) for non-producer municipalities compared to 0.67 for producer municipalities (from 2.87 in 2006 to 3.54 in 2017). As would be expected, the gap between the two types of municipalities decreased

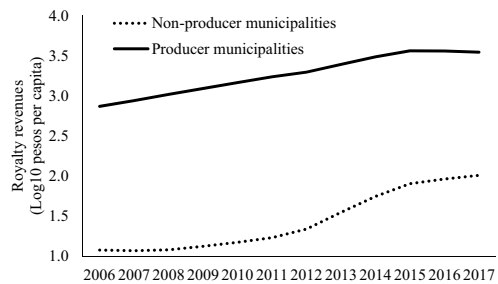

Figure 2. Royalty revenue received by municipalities in Colombia.

especially since the policy reform in 2012. The difference in received royalty revenue increased from 1.8 (log10 pesos per capita) in 2006 to 2.0 in 2011 and subsequently decreased to 1.5 in 2017. This provides face validity to our expectation that producer municipalities received relatively less royalty revenue compared to non-producer municipalities and therefore had to increase their fiscal effort.

Administrative efficiency refers to the extent to which municipal administrations turn inputs such as finances and personnel into policy outputs. The Departamento Nacional de Planeación (DNP) provides an indicator of administrative efficiency that is measured annually for each municipality. A data envelopment analysis lies at the core of this indicator, whereby output performance indicators in education, health, and drinking water are related to inputs in terms of human resources (quality and quantity of personnel) and capital investments in these three policy sectors (DNP 2005). For example, in education the number of students enrolled in preschools and middle schools and their exam scores (output) are evaluated against the total number of employed teachers, the experience of teachers, investment in education (not including payroll expenses), and classroom space (inputs). The best performing municipalities, i.e., the municipalities that are most efficient in providing a good or service, receive a score of 100% and other municipalities receive a score below 100% depending on how they compare to the best-performing municipalities. The final score is an average across three policy sectors: education, health, and drinking water (DNP 2005). Table A1 provides further detail. Our indicator for administrative efficiency does not directly assess efficiency regarding tax collection and we assume that municipalities, which are efficient regarding the provision of education, health, and drinking water, tend to be also more efficient in the collection of property tax.

The models used to test our hypotheses include eight control variables that are commonly used in research on fiscal effort of subnational jurisdictions (see e.g., Bonet-Morón, Pérez-Valbuena, and Ricciulli-Marín 2018; Crivelli and Gupta 2014; Mogues and Benin 2012; Vallés Giménez and Zárate Marco 2017). We include *transfers* from the central government – not including royalty revenue – and *total spending* by a municipality, which may either decrease or increase the incentives for a municipality to increase their tax revenue. Both transfers and total spending are measured as the logarithm (base 10) of pesos per capita in a given year.

We also include municipal *population size* and the sizes of *rural population* and of *population with age 65 or higher* within a municipality (we take the logarithms (base 10) of the population variables). Municipalities with larger total population sizes and smaller rural populations and smaller populations of 65 years and older may have more opportunities to increase their fiscal effort. In addition, one dummy traces whether the *mayor and president* are from the same party and another dummy indicates whether the *mayor and*

governor are from the same party. Party congruence may increase the probability that a municipality receives royalty revenue (Avellaneda 2012). Finally, we include the vote share won by the party of the mayor in the last municipal election. Mayors who can rely on the support of the municipal council may find it easier to increase the rate of the property tax.

Table 1 presents the descriptive statistics for the dependent and independent variables for non-producer and producer municipalities. Tables A2 and A3 in the appendix present, respectively, a correlation matrix and variance inflation scores for the independent variables. Our data set includes yearly data from 2006 to 2017 for 800 non-producer and 278 producer municipalities yielding a total of 12,936 yearly observations clustered by 1,078 municipalities. In Table A4 in the appendix we present the results for the full sample, which includes 13,164 yearly observations for 1,101 municipalities. The data come from four sources: The National Administrative Department of Statistics (DANE), the National Department of Planning (DNP), the National Registrar Office (NRO) and the Center for Economic Development Studies (CEDE).[10]

Method

Our dataset is a balanced panel which includes 12 years (t) from 2006 to 2017 for 1,078 municipalities (i). The first model is a fixed effects regression model that includes royalty revenues, administrative efficiency, eight control variables, municipal fixed effects to account for differences between municipal characteristics, and year fixed effects to account for exogenous shocks such as increases or decreases in oil prices.

$$PRT_{it} = RR_{it} + AE_{it} + \Psi_{it} + \alpha + \varsigma_i + \lambda_t + \in_{it}, \quad (1)$$

PRT_{it} is the property tax revenue raised by municipality i (= 1, . . ., 1078) in year t (= 2006, . . ., 2017). RR_{it} is the royalty revenue received by municipality i in year t and AE_{it} is the administrative efficiency of municipality i in year t. Ψ_{it} is a set of eight control variables: central government transfers, total spending, population size, rural population, population age 65 years and higher, congruence between the parties of the mayor and president, congruence between the parties of the mayor and governor, and proportion of votes for the party of the mayor. The model includes a constant term (α), fixed effects for municipalities (ς_i) and fixed effects for years (λ_t), and ε_{it} represents the error term. Standard errors in model 1 and in models 2–4 (see below) are adjusted for the clustering of observations by municipalities.

Year fixed effects control for possible exogenous shocks occurring in a particular year that may impact some or most of the observations. For example, royalty revenue is highly dependent on the price of oil, which is marked by volatility over time. Year dummies will absorb these differences between the years. A time trend variable does not assume effects specific to any given year;

Table 1. Descriptive statistics.

	All municipalities ($N = 1{,}078$)				Non-producer ($N = 800$)				Producer ($N = 278$)			
Variables	Mean	Std.dev.	Min	Max	Mean	Std.dev.	Min	Max	Mean	Std.dev.	Min	Max
Property tax revenues (log10 pesos per capita)	4,23	0,74	0	6,15	4,20	0,80	0	6,15	4,30	0,57	0	5,85
Royalty revenues (log10 pesos per capita)	2,83	2,28	0	7,14	2,46	2,24	0	6,79	3,91	2,03	0	7,14
Administrative efficiency	53,46	15,84	0	100	53,98	15,88	0	100	51,99	15,63	0	100
Dummy producer since 2012	0,13	0,34	0	0	0	0	0	0	0,50	0,50	0	1
Administrative efficiency producer since 2012	7,19	19,44	0	98,88	0	0	0	0	27,90	29,80	0	98,88
Transfers (log10 pesos per capita)	5,62	0,23	4,79	6,78	5,62	0,23	4,79	6,78	5,61	0,23	4,87	6,52
Total spending (log10 pesos per capita)	5,93	0,35	0	7,79	5,91	0,35	0	7,10	5,99	0,36	0	7,79
Population size (log10)	4,16	0,48	2,96	6,91	4,13	0,46	2,96	6,91	4,26	0,53	3,03	6,38
Rural population (log10)	3,84	0,38	2,49	5,24	3,81	0,37	2,49	4,87	3,92	0,41	2,83	5,24
Population over 65 years (log10)	3,06	0,45	1,67	5,77	3,03	0,44	1,67	5,77	3,15	0,48	1,96	5,35
Congruence mayor-president	0,45	0,50	0	1	0,45	0,50	0	1	0,45	0,50	0	1
Congruence mayor-governor	0,10	0,30	0	1	0,09	0,28	0	1	0,12	0,32	0	1
Proportion of votes for mayor's party	0,48	0,12	0	1	0,48	0,12	0	1	0,47	0,12	0	1

Total number of observations is 12,936 (12 years × 1,078 municipalities); 9,600 observations for non-producer municipalities (12 years × 800 municipalities), and 3,336 observations for producer municipalities (12 years × 278 municipalities).

instead, it assumes a monotonic process of growth or decline that extends across years and that may be associated with the trends in the dependent and independent variables. Figures 1 and 2 clearly reveal a trend of growth in property tax and royalty revenues for both producer and non-producer municipalities. Therefore, we run model 2, which is the same as model 1 but, rather than including fixed effects for years (λ_t), model 2 includes a trend variable that has a value of 1 for 2006, 2 for 2007, etc., up to 12 for 2017.

$$PRT_{it} = RR_{it} + AE_{it} + \Psi_{it} + \alpha + \varsigma_i + trend_t + \in_{it} \quad (2)$$

Models 3 and 4 return to the model specification of model 1, which includes fixed effects for years rather than a trend variable. Hypothesis three expects that producer municipalities in particular increased their fiscal effort after the policy reform in 2012. This hypothesis is assessed by including the variable *dummy producer since 2012* (*DP2012*) in model 3, which takes the value of 1 for producer municipalities for 2012 and later years and 0 for non-producers and years before 2012.

$$PRT_{it} = RR_{it} + AE_{it} + DP2012_{it} + \Psi_{it} + \alpha + \varsigma_i + \lambda_t + \in_{it} \quad (3)$$

Hypothesis four expects that producer municipalities with more efficient administrations will collect more property tax revenue after the policy reform in 2012. This hypothesis is assessed by including the variable *administrative efficiency producer since 2012* (*AEP2012*) in model 4. This variable traces the administrative efficiency scores for producers for 2012 and later years; and administrative efficiency scores are 0 for non-producers and years before 2012.

$$PRT_{it} = RR_{it} + AE_{it} + AEP2012_{it} + \Psi_{it} + \alpha + \varsigma_i + \lambda_t + \in_{it} \quad (4)$$

Models 3 and 4 apply a difference-in-difference model approach, whereby it is assumed that in the absence of the treatment (the 2012 policy reform), the difference between the comparison group (producer municipalities) and the control group (non-producer municipalities) is constant over time. The parallel trend assumption can be tested for the period before the 2012 policy reform and the null-hypothesis of parallel linear trends is not rejected for this period ($F(1, 1077) = 0.06$, $p = 0.8080$). It is important to note that this statistical test cannot be performed for model 4, because AEP2012 (i.e., the treatment) is a continuous variable. Visual inspection of Figure 3 reveals that prior to the 2012 policy reform, producer and non-producer municipalities followed a parallel trend in property tax revenue which seems to indicate that the parallel-trends assumption is satisfied. A robustness test is provided by Table A5 in the appendix which provides the results of an Arellano-Bond (system GMM) estimation applied to the four models that also include a lagged dependent variable.

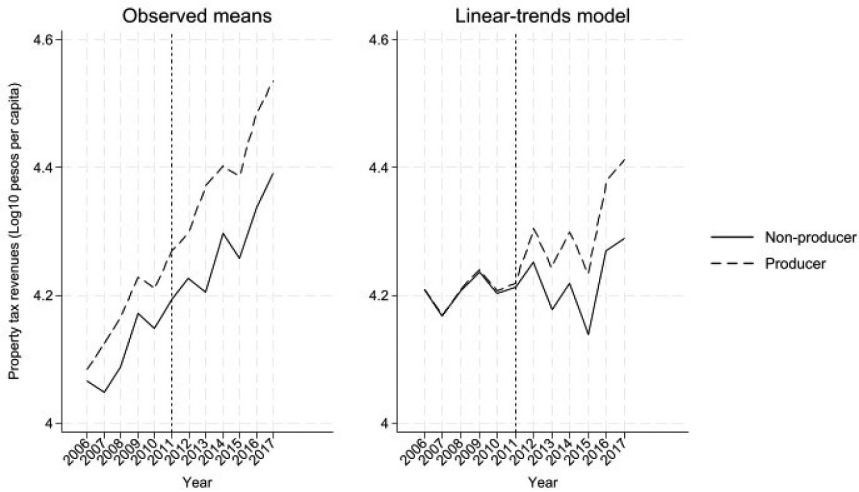

Figure 3. Trends in property tax revenues collected in producer and non-producer municipalities in Colombia, 2006–2017. The left panel in Figure 3 shows average tax revenues over time for producer and non-producer municipalities. The right panel in Figure 3 shows the predicted values for producer and non-producer municipalities based on augmented model 3, which excludes the variable DP2012 but includes interactions between the year dummies and a dummy with a value of 1 for producer municipalities and 0 for non-producer municipalities.

Results: the impact of royalty revenue and administrative efficiency on property tax revenue

Table 2 presents the results of four regression models. Royalty revenue does not reach statistical significance ($p < 0.05$) in model 1 but does in model 2, which includes a trend variable instead of fixed effects for years. Administrative efficiency reaches statistical significance at the 10% level in model 2, but its impact is not statistically significant in model 1. Both royalty revenue and administrative efficiency reach statistical significance in model 2, when we run the model for the full dataset of 13,164 yearly observations for 1,101 municipalities (Table A4). These results do not provide strong empirical support for hypotheses 1, which expects that municipalities that receive more royalty revenue raise less property tax revenue, nor for hypothesis 2, which expects that municipalities that are more administratively efficient raise more property tax revenue. The difference between the results of model 1, which includes year fixed effects, and model 2, which includes a trend variable, suggest that changing levels over time of royalty revenue and administrative efficiency can explain different degrees of fiscal efforts between municipalities.

Table 2. Impact of royalty revenues and administrative efficiency on municipal fiscal effort (property tax revenues).

	Model 1	Model 2	Model 3	Model 4
Royalty revenues	−0.0043	−0.0092***	−0.0017	−0.0017
	(0.0027)	(0.0025)	(0.0028)	(0.0028)
Administrative efficiency	0.0004	0.0006*	0.0004	0.0002
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Dummy producer since 2012			0.0859***	
			(0.0181)	
Administrative efficiency producer since 2012				0.0015***
				(0.0003)
Transfers	−0.1820**	−0.1824**	−0.1949**	−0.1952**
	(0.0807)	(0.0791)	(0.0799)	(0.0799)
Total spending	0.5256***	0.5070***	0.5260***	0.5267***
	(0.0389)	(0.0390)	(0.0385)	(0.0386)
Population size	0.1612	0.0716	0.0597	0.0307
	(0.4128)	(0.4109)	(0.4110)	(0.4118)
Rural population	−0.6884***	−0.6584**	−0.6799***	−0.6563***
	(0.2582)	(0.2561)	(0.2546)	(0.2535)
Population over 65 years	0.1805	0.2044	0.2266	0.2256
	(0.2332)	(0.2333)	(0.2304)	(0.2304)
Congruence mayor-president	−0.0013	−0.0033	−0.0015	−0.0018
	(0.0098)	(0.0087)	(0.0098)	(0.0098)
Congruence mayor-governor	0.0142	0.0156	0.0164	0.0163
	(0.0139)	(0.0137)	(0.0138)	(0.0138)
Proportion of votes for mayor's party	−0.0055	0.0033	−0.0046	−0.0027
	(0.0388)	(0.0388)	(0.0386)	(0.0386)
Trend		0.0104***		
		(0.0036)		
Constant	3.5231***	3.7774***	3.8378***	3.8754***
	(1.2466)	(1.2347)	(1.2472)	(1.2502)
Municipal fixed effects	YES	YES	YES	YES
Year fixed effects	YES	NO	YES	YES
Clustered standard errors	YES	YES	YES	YES

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Shown are the results (beta coefficients and their standard errors in between parantheses) of fixed effects models with 12,936 observations, 12 years × 1,078 municipalities. Standard errors are adjusted for the clustering of observations by municipality.

Based on the results of model 2, we find that a one unit increase in royalty revenue decreases property tax revenues by 0.009 units. When the means are taken as starting points (2.83 and 4.23 log10 pesos per capita, respectively, for royalty and property tax revenue; Table 1), then an increase of one unit corresponds to a 6,085 pesos per capita increase in royalty revenue (from 2.83 to 3.83 log10 pesos per capita), which leads to a 354 pesos per capita decline in property tax revenue (from 4.23 to 4.2179 log10 pesos per capita).

Based on the results of model 2, we find that a 10% increase in administrative efficiency increases property tax revenue by 0.006 units. When the mean property tax revenue is taken as a starting point, this impact corresponds to a 230 pesos per capita increase in property tax revenue (from 4.23 to 4.2330 log10 pesos per capita).

Models 3 and 4 in Table 2 return to the robust model specification that includes year fixed effects. The variable DP2012 reveals that producer

municipalities in particular increased their fiscal effort after the 2012 policy reform (model 3), a finding that provides strong support for hypothesis 3. Since 2012, producer municipalities raised 0.0859 (log10 pesos per capita) more property tax revenue than non-producer municipalities. This difference is statistically significant ($p < 0.01$) and, when we take the mean property tax revenue as a reference, we find that this difference corresponds to a 3,690 pesos per capita difference in property tax revenue (from 4.23 to 4.31 log10 pesos per capita). As indicated, it is plausible that producers increased their property tax revenue in response to the reduction in their entitlement to natural resource revenue.

Model 4 in Table 2 provides strong evidence for hypothesis 4, which expects that producer municipalities with more-efficient administrations will collect more property tax revenue after the policy reform in 2012. The variable AEP2012 is statistically significant ($p < 0.01$) and producer municipalities that increased their administrative efficiency by 10% after 2012 raise 0.015 (log10 pesos per capita) more property tax revenue. When we take the mean property tax revenue as a reference, we find that this difference corresponds to a 609 pesos per capita increase in property tax revenue (from 4.23 to 4.2425 log10 pesos per capita).

Conclusion and discussion

In conclusion, the results provide strong evidence for two out of our four hypotheses. We do not find conclusive evidence that municipal fiscal effort depends on the amount of received royalty revenue and the level of administrative efficiency of municipalities. However, when a trend variable instead of year fixed effects is included in the regression model, municipalities that receive less royalty revenue have a higher fiscal effort and collect more property tax revenue (hypothesis 1). Ramírez and Bedoya (2014) also find that a reduction in royalty revenue increases property tax revenues collected by municipalities. In addition, the model that includes a trend variable instead of year fixed effects reveals that municipalities with more efficient administrations raise more property tax revenue (hypothesis 2). This result is consistent with the findings of Postali (2015) who finds that fiscal capacity (measured by GDP per capita) is positively related to efficient tax revenue collection by Brazilian municipalities. The policy reform of 2012 produced clear incentives for producer municipalities to increase their fiscal effort by sharply reducing the amount of royalty revenue available to them. We find that producer municipalities increased their property tax revenue since 2012 (hypothesis 3) In particular, producer municipalities with efficient administrations were able to increase their fiscal effort (hypothesis 4).

Taken together, the results provide for an important insight regarding the assumption underlying the 'paradox of the plenty'. Scholars often take for

granted that local governments can increase their own revenue if they want to do so (Masaki 2018). However, the extent to which subnational jurisdictions can and will increase their fiscal effort in response to a decline in royalty revenue depends on their administrative efficiency. This finding has important implications especially for developing countries, where administrative efficiency tends to vary widely between local governments. These results also underline the importance of institutional quality to explain the extent to which subnational jurisdictions are subject to a 'natural resource curse' (Badeeb, Lean, and Clark 2017; Bulte, Damania, and Deacon 2005; Leibbrandt and Lynham 2018; Libman 2013; Mehlum, Moene, and Torvik 2006; Sachs and Warner 1995).

Another important insight concerns the role of the design of the policy used for the allocation of royalty revenue and for (un)conditional grants and inter-governmental fiscal transfers in general (see also e.g., Caldeira and Rota-Graziosi 2014; Cust and Viale 2016). An often-upheld assumption is that inter-governmental fiscal transfers from the central government decrease the incentives of subnational governments to increase their own-source revenue (Jaimes 2020). However, our results point out that in particular producer municipalities with high administrative efficiency increased their fiscal effort in response to a decrease in available royalty revenue. Given that more than two-thirds of Colombian municipalities are non-producing municipalities (812 versus 289 producer municipalities), this may explain why the results regarding the direct impacts of royalty revenues and administrative efficiency are inconclusive. This may also explain why Bonet-Morón et al. (2018) and Cadena (2002) find that increases in inter-governmental transfers do not decrease the fiscal effort of Colombian municipalities. Additionally, our finding that in particular producer municipalities with high administrative efficiency increased their fiscal effort may provide for an explanation for Colombia's 'exceptionalism'. Administrative efficiency might also help to explain why inter-governmental fiscal transfers are not invariably associated with decreased fiscal efforts of subnational governments in other countries such as Brazil (Monteiro and Ferraz 2010), Indonesia (Lewis and Smoke 2017), and Tanzania (Masaki 2018).

Overall, our results point out that the ability of municipalities to increase their fiscal effort is dependent on their administrative efficiency. This means that a country's ability to avoid a substitution effect in response to inter-governmental grants is dependent on the administrative efficiency of its municipalities. Thus, central governments are well advised to have policy in place that helps to increase the administrative efficiency of municipalities that have low institutional quality.

One of the main limitations of our study is its focus on Colombia, which implemented a specific policy reform in 2012. This may limit the external validity of our findings and thus a useful avenue for future research would

be to investigate to what extent administrative efficiency impacts fiscal effort of subnational jurisdictions in developed countries where administrative efficiency tends to be relatively high for all governments. In addition, future research should not only consider other developing countries to replicate our findings but also explore which characteristics of a policy design may impact the extent to which administrative efficiency moderates fiscal effort.

Notes

1. Dauvin and Guerreiro (2017) also attribute the mixed results in the literature to differences in the way in which royalty revenue is measured, which natural resources are considered, the employed econometric methods, the countries that are included in the dataset, and the control variables that are included in the models (see also Cust and Poelhekke 2015).
2. Our data set includes 1,078 municipalities because data for some years are missing for 23 municipalities. Table A4 in the appendix presents robustness analyses conducted by running our models for all 1,101 municipalities.
3. The 1991 constitutional revision was implemented by a national law adopted in 1993.
4. Additional sources of municipal revenue such as non-tax current revenue, current transfers, co-financing resources and other revenue, amounted to 24% of revenue before and after the 2012 policy reform.
5. Before the 2012 reform, municipalities with maritime or river ports that were used to transport natural resources were also considered to be producer municipalities (Bonet et al. 2015).
6. The lower limit has increased over time, from 0.1% before 2012 to 0.3% in 2012, and to 0.4% in 2013.
7. Municipalities can introduce a new municipal tax, but a new tax has to be approved by the National Congress. No municipality introduced a new municipal tax during the time period covered in the data set (Procuraduría General de la Nación 2011).
8. An example of an exception is that the property tax rate may be increased to a maximum of 3,3% in the case of undeveloped land in an urban area (Law No 1450 2011). The cadaster must be updated every five years and a mayor needs to initiate the process. In addition, every year the national geography institute selects municipalities that must update their cadaster (Shapiro et al. 2018). Almost 60% of the municipalities updated their cadaster between 2006 and 2010 (Martinez 2019).
9. See Bonet et al. (2015) for further detail on the development and approval of municipal development plans.
10. The data were retrieved from www.dane.gov.co (DANE) and www.terridata.dnp.gov.co (DNP).

Acknowledgments

Maria Antonieta Collazos-Ortiz would like to thank Maastricht University, The Netherlands.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The work was supported by the Trond Mohn stiftelse [TMS2019REK01 awarded to Arjan H. Schakel]; Universitetet i Bergen [812468 awarded to Arjan H. Schakel].

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