V JORNADAS IBEROAMERICANAS DE FINANCIAMIENTO LOCAL

A subnational resource curse? Revenue Windfalls and the Quality of Public Spending in Colombian municipalities

Martín Ardanaz
Nuria Tolsá Caballero

Santiago de Compostela, octubre de 2016

Contents

Introduction 3
1. Background 5
2. Data 9
3. Evidence 10
3.1. The impact of fiscal windfalls on revenue and expenditure patterns 11
3.2 Efficiency of local public good provision 12
3.2.1 Determinants of public spending efficiency at the local level 13
3.2.2 Robustness checks 15
3.3. Revenue windfalls and corruption 18
Conclusions 21
Appendices 23
APPENDIX A. methodology for the distribution of royalty payments from the FNR 23
APPENDIX B. The New System (2012 on) 23
Appendix C. The determinants of expenditure efficiency using DEA (IV 2SLS with coal as instrument) 25
References 28

Figures

Figure 1- Production of oil and coal 6
Figure 2- Evolution of royalty payments and shares across SNGs 7
Figure 3-Evolution of international prices of oil and coal 8
Figure 4- Royalty Payments 9
Figure 5-Distribution of municipal efficiency scores, by department 13
Figure 6-Marginal effect of royalties on spending efficiency, with 95% confidence intervals 15
Figure 7-Quantile regression coefficients 18
Figure 8 - Marginal effects of royalties on incidence of corruption, with 95% confidence intervals 20

Tables

Table 1-The effects of royalty payments on municipal revenues and expenditures (fixed effects) 11
Table 2-The determinants of expenditure efficiency using DEA (Tobit regressions) 14
Table 3- The determinants of expenditure efficiency using DEA (IV 2SLS) 16
Table 4 - The determinants of expenditure efficiency using FDH (Tobit regressions) 17
Table 5 - Determinants of the incidence and size of irregularities (Tobit and OLS regressions) 19

Maps

Map 1 - Distribution of royalty payments in Colombia (average 2004-2011) 27

A subnational resource curse? Revenue Windfalls and the Quality of Public Spending in Colombian municipalities

Martin Ardanaz[**]

Inter-American Development Bank

Nuria Tolsa Caballero[***]

Inter-American Development Bank

Abstract

This paper explores the impact of revenue windfalls from oil and mineral resources on the quality of public expenditures across Colombian local level governments during the latest commodity price cycle. Exploiting subnational variation induced by the allocation rules of natural resource transfers, we estimate the effects of receiving additional revenue windfalls on three outcomes of interest: composition and level of public spending, efficiency of government expenditures in the water & sanitation and health sectors, and the extent of corruption. Based on a dataset comprising more than 1000 municipalities between 2004 and 2011, this paper finds that while revenue windfalls are accompanied by expenditure increases across all types of sectors, a non-monotonic relationship emerges between the efficiency of spending, the extent of corruption and the level of natural resource transfers: municipalities that were extremely favored by the commodity boom where more inefficient and more likely to engage in corrupt behavior whereas those benefited with modest transfers were more efficient and less corrupt.

[**] Corresponding author: Inter-American Development Bank, Boulevard Jean Paul Genie, Managua, Nicaragua. E-mail: martina@iadb.org

[***] Inter-American Development Bank, 1300 New York Avenue, N.W., Washington, DC 20577, USA. E-mail: nuriat@iadb.org

Introduction

The latest commodity price cycle has renewed the interest of policymakers and scholars alike in old questions regarding the role of natural resources in economic development (Sachs and Warner 1995, Karl 1997; Ross 1999). In particular, the fiscal consequences of resource booms have received increased attention, both at the national (ECLAC 2015; IMF 2014) and subnational levels (Caselli and Michaels 2013; Loayza et al 2013). Specifically, subnational governments (SNGs) around the world have experienced large increases in their budgets as a consequence of institutional frameworks that grant them access to an important share of fiscal revenue from nonrenewable resources (Brosio and Jimenez 2012). For example, in countries such as Bolivia, Peru or Brazil, the share of fiscal revenue from minerals or hydrocarbons that is allocated at the subnational level is between 60% and 70% (Morgandi 2008). In the case of Colombia, the focus of this study, SNGs have almost exclusive access to this type of fiscal revenue (OECD 2014; DNP 2007).

Are SNGs spending natural resource windfalls in an efficient manner? This paper studies the Colombian experience to shed light on this question, by exploiting municipal variation in access to natural resource rents (oil and coal royalties) and measuring their impact on public spending efficiency in two sectors where local governments enjoy substantial jurisdiction (health, and water & sanitation). Based on a rich dataset comprising more than 1000 municipalities between 2004 and 2011, and relying on standard non-parametric techniques to measure public expenditure efficiency (Data Envelopment Analysis) we find that the relationship between revenue windfalls and public spending efficiency is non-monotonic: municipalities that were extremely favored by the commodity boom were more inefficient whereas those benefited with modest transfers were more efficient. These results are consistent with recent theoretical work suggesting that the level or "intensity of dosage" of natural resource revenues is a key determinant of policymakers' incentives and thus, of the economic and political outcomes associated with resource abundance in developing countries (Caselli and Cunningham 2009).

In contrast to the effect of oil and coal royalties, increases in municipal own revenue sources (property and business taxes) have positive effects on expenditure efficiency. Finally, the extent of observed corruption is positively associated with the level of resource revenue transferred to municipalities. Both findings are also consistent with recent theoretical and empirical work linking government performance to the structure of public finance at the

subnational level (Gadenne 2013; Ramirez 2014). According to this literature, it is crucial to focus on how natural resource transfers and taxation affect politicians' incentives and behavior. In particular, access to large amounts of windfall revenue has the potential of: i) exacerbating the political agency problem, both in terms of moral hazard and selection effects[1] (Brollo et al. 2013; Monteiro and Ferraz 2012); and ii) changing the degree or nature of political competition[2] (Caselli and Cuninghman 2009; Acemoglu et al. 2006), thus affecting governments' incentives to provide public goods efficiently. While exploring in depth such mechanisms is beyond the scope of this paper, we provide reduced form evidence suggesting a relationship between different sources of government revenue and public policy outcomes (public spending efficiency, and levels of corruption), which is an important first step in the direction of understanding the linkages between different public finance structures and government performance.

This paper is organized as follows. Section 1 presents stylized facts about Colombian local governments' revenue sources, spending responsibilities, as well as the rules regarding the distribution of oil and mineral wealth across and within the different government tiers. After briefly describing the data sources to be used in the empirical analysis in Section 2, Section 3, the core of the paper, contains three different but related empirical exercises. In particular, the section analyzes the effect of additional revenue windfalls on a) the size and composition of local budgets; b) the (technical) efficiency of local public spending in water & sanitation and health sectors, and c) the incidence of corruption. Conclusions follow.

[1] Specifically, revenue windfalls increase budget size, providing extra room for politicians to tilt the allocation of spending toward goods that benefit the incumbent (perks, rents) at the expense of voters. Since rents are more valuable for political candidates of lower quality, a larger budget induces a decline in the average ability of the pool of candidates (Brollo et al. 2013).

[2] The effect of windfalls on political competition is theoretically ambiguous: on the one hand, it may increase the likelihood of a political challenge, but it could also lead to an incumbency advantage effect in which electoral competition is reduced by the use of patronage or clientelistic strategies (Caselli and Cuningham 2009).

1. Background

Fiscal federalism and local public finance. Colombia is a unitary but highly decentralized country consisting of 1100 municipalities distributed among 32 departments.[3] Subnational governments are responsible for a wide range of competences, including education, health, domiciliary public services, water and sanitation, among others. Although departments are responsible for co-financing some municipal expenditures, municipalities are accountable for a wider range of responsibilities than departments, representing around 65 percent of total subnational expenditure. In total, expenditures from subnational governments (SNGs) account for a third of non-financial public sector spending (i.e. around a 9.6 percent of GDP), of which health and education represent more than 50 percent.

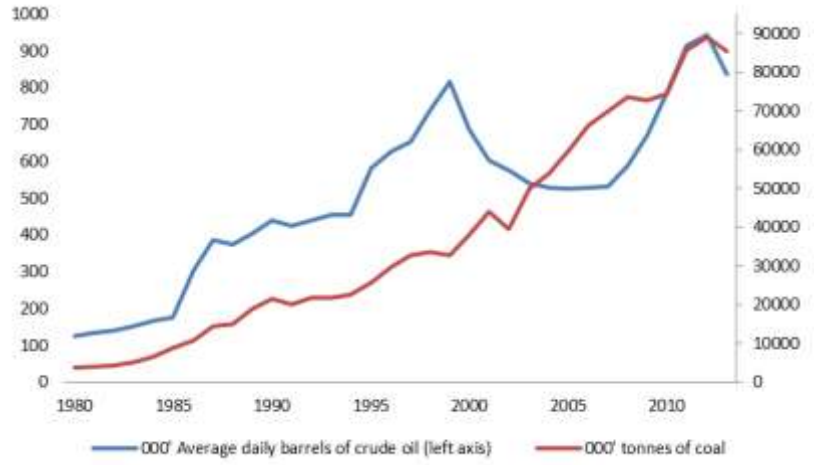
This high degree of decentralization on expenditures contrasts with the low level of own revenues raised by SNGs, leading to high vertical fiscal imbalances. SNGs have basically four sources of revenues: own revenues (tax and non-tax revenues), transfers from the SGP[4], royalty payments and other transfers. Subnational revenues account for around 9-10 percent of GDP, almost paired with expenditures, but the lion's share of subnational revenues (65%) are transfers and royalty payments, of which 46 percent are transfers from SGP, 8 percent royalty payments, and 11 percent transfers from other sources. This means that whereas transfers and royalty payments finance around 65 percent of expenditures, own revenues just finance around 35 percent. Furthermore, most of the social, infrastructure, and other public services expenditures are financed with earmarked resources, which gives little room for flexibility. For example, around 95 percent of SGP transfers are earmarked for education, health, school meals, water and sanitation (World Bank 2009).

Royalty payments and the boom of oil and coal production in Colombia. Although the beginning of oil and mineral exploitation in Colombia dates back to colonial times, it was not until the 1980s that production boomed. Since the mid-1970s, successive legal reforms leading to the decrease of red tape in the exploitation of oil and the substitution of concessions by association contracts led to the discovery of new oil fields and boosted production. Likewise, with the determination to reach international markets and the beginning of coal exports from El

[3] Departments and municipalities are respectively headed by governors and mayors , directly elected for a period of 4 years, without the possibility of immediate reelection.
[4] Sistema General de Participaciones (SGP). It is the main intergovernmental system of transfers from the State to subnational entities in Colombia.

Cerrejon in the 1980s, coal production boomed. Indeed, while average oil production in the period 2000-2010 almost quadrupled with respect to 1970-1980, average coal production increased by a factor of more than 17 (Figure 1). While Colombia produces other minerals such as niquel, iron, copper, gold and other precious metals, the bulk of mineral exports proceed from oil, followed by coal. Together, oil and coal accounted for 85 percent of total mineral and oil exports, of which 70 percent were oil and its derivatives.

Figure 1- Production of oil and coal

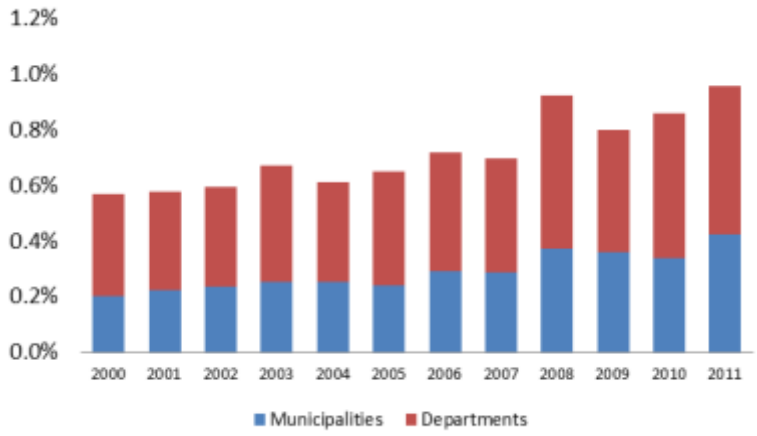


The increase of oil and mineral production in the 1980s was accompanied by the decentralization of Colombia's governance model, which up till 1991 was highly centralized, with mayors and governors directly appointed by the President. The Constitutional reform of 1991 devolved competences to SNGs, introduced democratic elections of governors and established the main principles of the participation of SNGs in the revenues generated by extractive activities. Under this legal framework complimented by Law 141 of 1994, the State would be the owner of the subsoil and of the non-renewable natural resources (Art 332 Constitution), and would charge royalties for the production of these goods, with SNGs being the main beneficiaries and receiving around 97 percent of total royalty payments. However, there were substantive differences across the amount received by the different municipalities, most of these explained by allocation rules favoring producing regions (Perry y Olivera 2009). Indeed, those territories involved in the exploration, exploitation or logistics of transportation of non-

renewable natural resources (hereinafter, "producers"), would be the main beneficiaries of royalty payments (i.e. direct royalty payments), receiving around 80 percent of the total.[5]

The bulk of royalty payments ("regalias directas") were to be earmarked for investment in contributions to the National Pension Fund (Fondo Nacional de Pensiones en las Entidades Territoriales, FONPET), and the following sectors: education, health (infant mortality and health-for-the-poor projects), and water supply and sewerage. The remaining resources ("regalías indirectas") -about 20% of total- were allocated to the National Royalties Fund (FNR), as a mechanism of interregional redistribution: while both producing and non-producing municipalities were eligible for payments under the FNR, in practice producing regions were favored the most (Ministerio de Hacienda y Credito Publico 2011). Considering total royalty payments paid to SNGs, departments have historically been the major beneficiaries, receiving a share between a 55% and a 65%, and municipalities the remaining 35% -45%.[6] Royalties distributed to SNGs almost doubled in the last decade, from 0.57% of GDP in 2000 to 0.96% of GDP in 2011, with oil and coal accounting for 67 percent and 19 percent of total royalty payments respectively accruing to municipalities (Figure 2). [7]

Figure 2- Evolution of royalty payments and shares across SNGs



[5] The amount to be received by producer districts was determined according to a formula depending on the volume of oil/minerals produced, the price of the mineral set by the Ministry of Mines and Energy for the payment of royalties, and a tax rate set for each mineral or oil, which stands between 8 and 25 percent for oil and between 5 and 10 percent for coal, depending on the volume produced.

[6] The new system has been designed in order to further increase the department's participation in the system. The budgets for 2012 and 2013-2014 foresee a 75% share and a 77% share respectively.

[7] As shown in Figure A1, royalties are significantly more volatile than other kind of revenues sources.

Part of the increase is explained by the raise in production (33 percent for oil and 125 percent for coal), and part by the commodity price boom: between 2000 and 2011, international real prices of oil increased by almost 170 percent and those of coal by 222 percent (Figure 3).

Figure 3 - Evolution of international prices of oil and coal

Regional disparities in access to royalty payments. Due to the allocation rule favoring producing districts, the amounts received by the different SNGs differ greatly (DNP 2012).[8] In contrast with SGP transfers, transfers from royalties up to 2011 were highly concentrated in a few SNGs[9]. Three departments out of the total 32, which only represent 5% of the population, received 54% of the total royalties. At the municipal level, differences were even more pronounced (Bonet y Ubiergo 2014). Whereas more than 40% of the municipalities did not receive any royalty payments at all, just 10% (109 municipalities) received 87.7% of total municipal royalties. Just 24 of them, representing a 9.6% of the population, received more than 50% of the royalty payments addressed to municipalities (Figure 4a). Map 1 (Appendix) shows the degree of geographic concentration of royalty payments.

[8] This feature is not unique to Colombia. In other countries such as Brazil (Ardanaz 2014) or Peru (Maldonado 2014; Sanguinetti 2009), similar allocation formulas tend to favor only a minority of subnational governments. See Morgandi (2008), Viale and Cruzado (2012) for more general overviews.

[9] With regards to the royalties specifically distributed to departments, the Gini coefficient of royalties per capita for the period 2000-2011 stood at 0.83 which is very high when compared to the 0.41 of transfers and the 0.3 of tax revenues. At a municipal level, differences were even more pronounced. The Gini coefficient amounted to 0.93, significantly above the 0.51 for tax revenues and the 0.31 for transfers.

Figure 4- Royalty Payments

Figure 4a: Royalty Payments to Municipalities

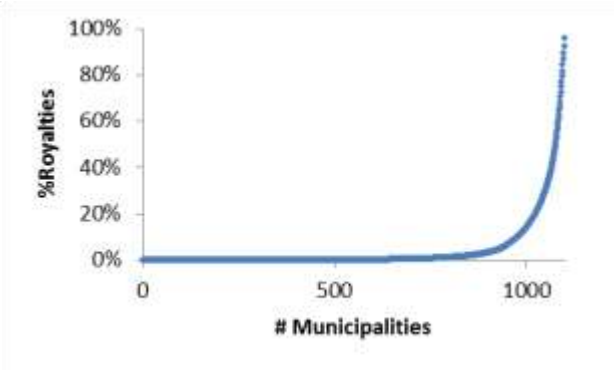
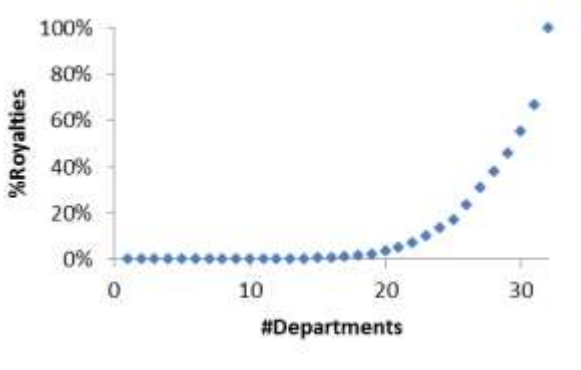


Figure 4b: Royalty Payments to Departments



It is important to note that the distribution criteria changed in 2012, with a new law aiming to make the participation more equitable across subnational governments. However, the fact that oil and mineral endowments (or proximity to it) were key determinants of this extra revenue stream until 2011 provides the researcher with an important source of exogeneity to study the effects of fiscal windfalls on local public finance. In addition, given the asymmetry in the distribution of revenue windfalls across municipalities, in the empirical analysis we explore whether the effects of such revenue source are conditional on the intensity or level of transfers received.

2. Data

Detailed public finance data was obtained from the Colombian Department of National Planning (DNP), and includes information on municipal total fiscal revenues, own tax revenues sources (IRCA and IPU), intergovernmental transfers (SGP), and royalty payments. On the expenditure side, the data covers total, current, capital and sector specific expenditure items (health, education, water and sanitation).

Information on oil production per field was facilitated by the National Agency of Hydrocarbons (ANH). Since some fields are located in more than one municipality, we assigned the oil output associated to each field proportionally to the area located in each respective municipality. For coal production at the municipal level, we used data from the Colombian Mining Information System (SIMCO). International oil and coal prices were obtained from the World Bank's International Commodity Prices Pink Sheet Database: crude oil (average) and Colombian coal. In order to obtain the value of production for each commodity in a given year, we multiplied the volume of production by its international price.

For the efficiency analysis, we collected data on inputs (expenditures in the health and water & sanitation sectors) with corresponding outcome measures: the mortality infant rate (TMI), which measures the number of deceases in children less than one year old, for each 1,000 children born alive, and the *Index of Risk of Water Quality for Human Consumption* (IRCA), an index ranking from 0 to 100 that measures the risk of diseases related for the non-fulfillment of the chemical, physical and microbiological characteristics required for human consumption.[10] Since public spending produces benefits only with some lag, we take average expenditures between 2004 and 2011 and measure outcomes in subsequent periods: 2011 (TMI) or 2010-2012 (IRCA).[11] Thus, this analysis is based on cross-sectional level data.

Thirdly, for the corruption analysis, we used information regarding irregularities in the use of royalty payments from the DNP. In particular, we used two variables: 1) the percentage of the value of contracts financed with direct royalties subject to irregularities between 2009 and 2011; 2) Number of irregularities in contracts financed with direct royalties between 2009 and 2011. Finally, standard economic control variables such as the Basic Needs Index ("NBI") and "percentage of urban population" were obtained from the National Institute of Statistic (DANE), and political variables such as "margin of electoral victory", defined as the difference in vote shares between the elected candidate and the runner up in mayoral elections, come from the Colombian national elections council: Registraduría Nacional del Estado Civil.

3. Evidence

In this section, we conduct three empirical exercises: we first analyze how windfall revenues impact multiple items of the fiscal accounts. We then estimate the impact of royalty payments on the efficiency of government spending in the water & sanitation and health sectors. Finally, we test the hypothesis that higher fiscal windfalls, in the form of royalty payments, are associated with higher incidence of corruption.

[10] If the index is between 0 and 5, there is risk. If it is between 5.1 and 14, the risk is low. If it is between 14.1 and 35, the risk is medium. If the index is between 35.1 and 70 the risk is high. Finally, if the index is between 70.1 and 100 the risk is unviable.
[11] In a future version of the paper, we plan to present results from the education sector as well.

3.1. The impact of fiscal windfalls on revenue and expenditure patterns

Do royalties induce fiscal laziness by affecting incentives to tax? Do they alter expenditure patterns by changing the composition of the budget? To answer these questions, we ran OLS regressions for different revenue and expenditure components on royalty payments for the period 2004-2011 including municipal and year fixed effects as controls, which are presented in Table 1. [12]

Table 1-The effects of royalty payments on municipal revenues and expenditures (fixed effects)

	Revenues			*Expenditures*			
	Fiscal	Tax	Total	Current	Capital	Health	Water & Sanitation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Royalties pc (log)	0.011***	-0.000	0.010***	0.002*	0.011***	0.004**	0.015***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
% increase	6.8%	0.0%	6.2%	1.2%	6.8%	2.5%	9.2%
Observations	12,838	12,812	12,893	12,861	12,859	12,797	12,799
Number of municipalities	1,097	1,097	1,097	1,097	1,097	1,097	1,097

Robust standard errors in parenthesis

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

An increase in royalty payments per capita is associated with an increase in both revenues and expenditures, although as we can see, the size of the impact varies from one category to another. Columns (1) and (2) show how fiscal windfalls lead to an increase in total revenues. On average, an increase of one standard deviation in royalty payments per capita is associated with a 6.8% increase in total revenues per capita. The increase in revenues is also accompanied by an increase in spending, with total expenditures per capita, on average, increasing by 6.2 percent with a one standard deviation increase in royalty payments per capita. However the impact seems to be much larger for capital expenditures than for current expenditures, which is expected since rules regarding the allocation of royalties command this type of revenue stream to be earmarked for investment expenditure. Whereas a standard deviation increase in royalty payments per capita is associated with a 1.2 percent increase in current expenditures per capita, the effect on capital expenditures is more than 5 times larger, with in the same increase in royalty payments per capita being associated with a 6.8 percent increase in capital expenditures.

[12] All variables enter in per capita terms and in logs.

With respect to the impact on the levels of spending on the different sectors, the impact was statistically significant in both the water & sanitation and health sectors. However, the impact was considerably larger in the first: whereas a standard deviation increase in royalty payments per capita is associated with a 9.2 percent increase in per capita spending in the water & sanitation sector, the same increase is associated with just a 2.5 percent increase in per capita spending in the health sector.

3.2 Efficiency of local public good provision

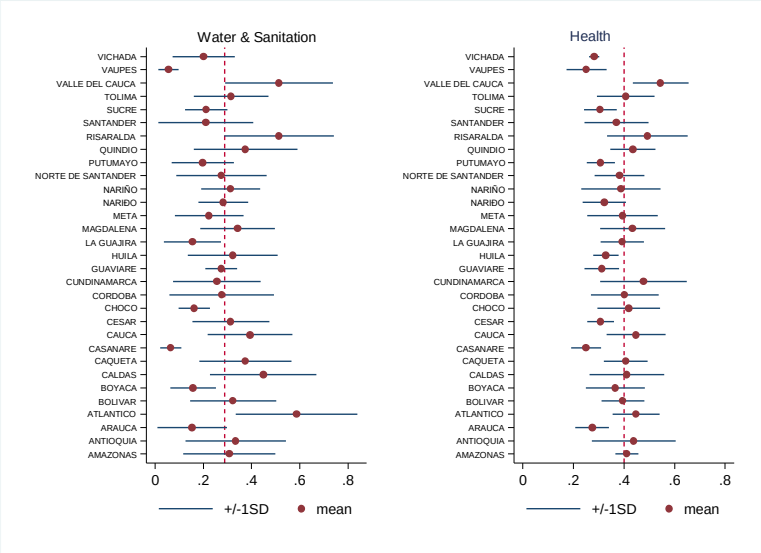
The previous section highlights how an increase in revenues from royalty payments leads to public spending increases of different categories. How efficiently are municipalities using these resources? Although public spending efficiency can by analyzed from two perspectives, allocative and technical, we focus on the latter dimension, using a standard non-parametric methodology: Data Envelopment Analysis (DEA).[13] The DEA technique takes a given municipality and compares it with the best performer(s) of peer municipal governments in the sample. This leads to an empirical approximation of a production possibility frontier, defined as the maximum attainable outcome by a SNG for a given input-level (input-oriented approach) or as the minimum required input to attain a given outcome-level (output-oriented approach). Inefficiency is defined as the distance from the observed input-output combinations to the efficiency frontier. Municipalities on the frontier will exhibit scores of 1, and less efficient governments will show scores between 0 and 1. As inputs for the water & sanitation and health sectors, we used average public spending per capita for the period 2004-11 in each respective sector. As outcomes, we used the water quality index (IRCA)[14] for the water & sanitation sector and the infant mortality rate[15] for the health sector, both described in section II.

Figure 5 shows local level variation in efficiency scores across spending sectors; with municipal scores averaged by department (dashed vertical lines represent sample averages).[16] In terms of measurement validity, it is reassuring that both sector specific measures are positively correlated

[13] Later on in the paper we derive efficiency scores using an alternative common approach: Free Disposable Hull (FDH).
[14] We took the average of the index for the years 2010-2012. Since larger values of the index mean worse water quality, we used the reverse of the index as the outcome measure (i.e. 100-IRCA).
[15] We used the last available data (2011), and the output is measured as 100-infant mortality rate.
[16] The pairwise correlation (rho=0.5) suggests that those municipalities relatively efficient in the water and sanitation sector are also relatively efficient in the provision of other public services such as health.

with a broader efficiency ranking periodically generated by the DNP (Figures A1 and A2, Appendix).[17]

Figure 5 - Distribution of municipal efficiency scores, by department



3.2.1 Determinants of public spending efficiency at the local level

Table 2 presents results from Tobit models in which efficiency scores are regressed against royalty payments per capita and a series of control variables: total public expenditures per capita, intergovernmental transfers per capita, own tax revenues per capita, percentage of urban population, a measure of poverty (NBI), and the margin of victory in mayoral elections.[18] Since we are interested in testing whether the impact of natural resource windfalls on efficiency is conditional on its level, we include a quadratic term (royalties^2) across all specifications.

[17] DNP's efficiency score is a component of the Municipal Comprehensive Performance Assessment Index. The aforementioned efficiency score is the average of six different efficiency scores on the education, health and water& sanitation sectors (two per sector), which are calculated using the DEA methodology as well (see DNP 2014).
[18] ROYALTIES, ROYALTIES^2, EXPENDITURES, TRANSFERS AND TAX REVENUES enter the model in logs. All the variables are averages for the period 2004-2011.

Table 2 - The determinants of expenditure efficiency using DEA (Tobit regressions)

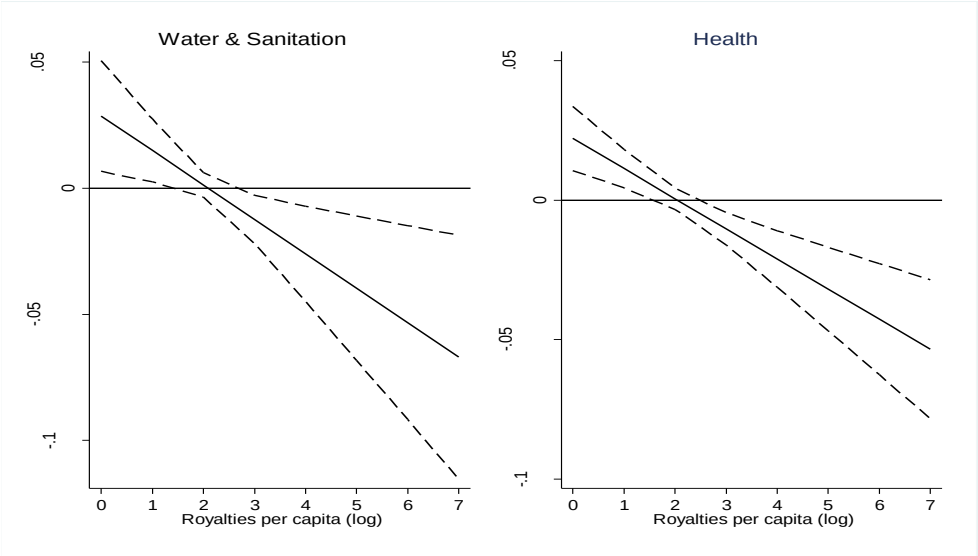
	Efficiency scores: water quality index				Efficiency scores: infant mortality rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ROYALTIES	0.113***	0.032***	0.030***	0.029***	0.055***	0.024***	0.023***	0.022***
	(0.009)	(0.011)	(0.010)	(0.011)	(0.007)	(0.006)	(0.006)	(0.006)
ROYALTIES^2	-0.025***	-0.008***	-0.007***	-0.007***	-0.012***	-0.006***	-0.006***	-0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
EXPENDITURES		-0.647***	-0.589***	-0.597***		-0.098**	-0.068*	-0.052
		(0.116)	(0.106)	(0.125)		(0.043)	(0.039)	(0.041)
TRANSFERS		-0.105	-0.049	0.004		-0.359***	-0.338***	-0.360***
		(0.099)	(0.090)	(0.105)		(0.044)	(0.043)	(0.044)
TAX REVENUES		0.131***	0.080***	0.089***		0.097***	0.077***	0.047***
		(0.032)	(0.029)	(0.031)		(0.015)	(0.013)	(0.014)
% URBAN POPULATION			0.002***	0.002***			0.001***	0.001***
			(0.000)	(0.000)			(0.000)	(0.000)
NBI			-0.000	-0.000			0.000	-0.000
			(0.000)	(0.000)			(0.000)	(0.000)
MARGIN OF VICTORY			-0.022	-0.005			-0.019	-0.045**
			(0.027)	(0.026)			(0.021)	(0.020)
Department FE?	N	N	N	Y	N	N	N	Y
Observations	1,045	1,045	1,045	1,045	1,076	1,076	1,076	1,076

Robust standard errors in parentheses

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

Columns four and eight present results from our preferred specification in which in addition to standard fiscal and socioeconomic controls, department fixed effects are included. While the relationship between the level of royalty payments and efficiency is positive, the square term is negative and significant. Since the average amount of royalties per capita is 59,874.45 pesos (circa US$30), this implies that the efficiency score is negatively associated with natural resource transfers for the typical municipality. In fact, the combined effect of the parameters is negative for the range of royalty payments found in the vast majority of municipalities (80% of municipalities). These conditional effects are illustrated in Figure 6, which presents the marginal effects from the previous specifications.

Figure 6 - Marginal effect of royalties on spending efficiency, with 95% confidence intervals



The economic significance of these coefficients is important: a standard deviation increase in royalties per capita is associated with 10.9 percent and 5.4 percent decreases in efficiency for the water & sanitation and health sectors respectively, relative to the average efficiency scores. An increase in SGP transfers seems to decrease efficiency in the health sector as well, with a standard deviation increase in transfers per capita being associated with a decrease of 16.5 percent with respect to the average efficiency score. In contrast, an increase in local tax revenues would lead to gains in public spending efficiency in both the water & sanitation and health sectors. Indeed, a standard deviation increase in own revenues per capita is associated with efficiency gains of 10.3 percent in the water & sanitation sector and 3.9 percent in the health sector, with respect to their respective average efficiency scores. Note that the impact is almost of the same size as the increase in royalty payments but in the exact opposite direction: whereas royalty payments decrease public spending efficiency, tax revenues seem to lead to efficiency gains.

3.2.2 Robustness checks

A. Identification

The analysis so far has assumed that royalty payments are exogenous to local characteristics. However, as discussed in section 1, allocation of natural resource transfers is directly linked to

production levels (Dube and Vargas 2013).[19] Thus, to circumvent potential endogeneity concerns, and in order to causally identify the impact of royalty payments on efficiency, we turn to an instrumental variable (IV) approach, in which natural resource transfers are instrumented by oil output levels per capita, thus exploiting the exogenous distribution of oil reserves across the territory (Table 3).[20]

Table 3- The determinants of expenditure efficiency using DEA (IV 2SLS)

	Efficiency scores: water quality index				Efficiency scores: infant mortality rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ROYALTIES	0.078***	0.053*	0.025	0.062**	0.067***	0.154***	0.140***	0.084***
	(0.024)	(0.030)	(0.028)	(0.026)	(0.020)	(0.026)	(0.024)	(0.021)
ROYALTIES^2	-0.019***	-0.012**	-0.006	-0.013**	-0.014***	-0.031***	-0.028***	-0.018***
	(0.004)	(0.006)	(0.006)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)
EXPENDITURES		-0.604***	-0.598***	-0.522***		0.148**	0.152**	0.076
		(0.129)	(0.126)	(0.130)		(0.067)	(0.064)	(0.056)
TRANSFERS		-0.127	-0.045	-0.039		-0.489***	-0.465***	-0.438***
		(0.101)	(0.099)	(0.104)		(0.053)	(0.054)	(0.050)
TAX REVENUES		0.121***	0.081**	0.079***		0.043**	0.039**	0.028*
		(0.034)	(0.032)	(0.030)		(0.020)	(0.017)	(0.015)
% URBAN POPULATION			0.002***	0.002***			0.001***	0.001***
			(0.000)	(0.000)			(0.000)	(0.000)
NBI			-0.000	-0.000			0.000	-0.000
			(0.000)	(0.000)			(0.000)	(0.000)
MARGIN OF VICTORY			-0.024	0.002			-0.005	-0.031
			(0.026)	(0.027)			(0.025)	(0.021)
Constant	0.285***	3.889***	3.539***	3.061***	0.370***	1.942***	1.771***	2.143***
	(0.023)	(0.214)	(0.219)	(0.235)	(0.019)	(0.175)	(0.176)	(0.168)
Department FE?	N	N	N	Y	N	N	N	Y
				First stage results for royalties				
Value of oil production per capita	0.332***	0.267***	0.259***	0.284***	0.324***	0.264***	0.257***	0.279***
	(0.013)	(0.017)	(0.017)	(0.022)	(0.013)	(0.017)	(0.017)	(0.022)
R-squared	0.121	0.153	0.184	0.322	0.114	0.141	0.177	0.318
Cragg-Donald Wald F statistic	92.591	75.721	78.698	93.627	91.728	76.414	77.894	99.009
Kleibergen-Paap F statistic	72.509	72.433	77.763	74.946	79.15	76.403	79.576	88.213
Observations	1,045	1,045	1,045	1,045	1,076	1,076	1,076	1,076

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

Columns 1-8 show a strong and significant relationship between the instrumental variable and the level of royalty payments per capita. A 1% increase in oil production per capita is associated with up to 0.33 percentage point increase in royalty payments. In addition, the F-statistics reject the null hypothesis that the instrument is weak. The second stage results show even larger conditional impacts of royalty payments on efficiency levels.

[19] Dube and Vargas (2013) use an interaction between a time varying variable (the price of oil) and a cross-sectional measure of oil production in their analysis of the impact of commodity price shocks on civil conflict in Colombia. Our instrument uses time variation in both dimensions to generate average production levels.

[20] We don't find similar results when instrumenting total royalty payments with coal production per capita (Appendix D, Table 1)

B. Alternative technique for deriving the efficiency frontier: Free Disposable Hull (FDH)

While Data Envelopment Analysis (DEA) is the most common non-parametric framework to derive efficiency scores, a common alternative found in the literature is the Free Disposable Hull (FDH) technique. Table 4 presents results from re-estimating the original Tobit specification using FDH efficiency scores. The relevant coefficients are similar to the ones found using the DEA approach, both in terms of the statistical significance of the variables and in terms of the size of the coefficients.

Table 4 - The determinants of expenditure efficiency using FDH (Tobit regressions)

	Efficiency scores: water quality index				Efficiency scores: infant mortality rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ROYALTIES	0.116***	0.034***	0.032***	0.030***	0.055***	0.024***	0.023***	0.022***
	(0.009)	(0.011)	(0.010)	(0.011)	(0.007)	(0.006)	(0.006)	(0.006)
ROYALTIES^2	-0.026***	-0.008***	-0.008***	-0.007***	-0.012***	-0.006***	-0.006***	-0.005***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
EXPENDITURES		-0.660***	-0.600***	-0.611***		-0.098**	-0.068*	-0.052
		(0.117)	(0.107)	(0.126)		(0.043)	(0.039)	(0.041)
TRANSFERS		-0.112	-0.054	0.004		-0.360***	-0.338***	-0.360***
		(0.100)	(0.092)	(0.106)		(0.044)	(0.042)	(0.044)
TAX REVENUES		0.138***	0.086***	0.097***		0.097***	0.077***	0.047***
		(0.033)	(0.030)	(0.032)		(0.015)	(0.013)	(0.014)
% URBAN POPULATION			0.002***	0.002***			0.001***	0.001***
			(0.000)	(0.000)			(0.000)	(0.000)
NBI			-0.000	-0.000			0.000	-0.000
			(0.000)	(0.000)			(0.000)	(0.000)
MARGIN OF VICTORY			-0.024	-0.005			-0.019	-0.045**
			(0.027)	(0.027)			(0.021)	(0.020)
Department FE?	N	N	N	Y	N	N	N	Y
Observations	1,045	1,045	1,045	1,045	1,076	1,076	1,076	1,076

Robust standard errors in parentheses

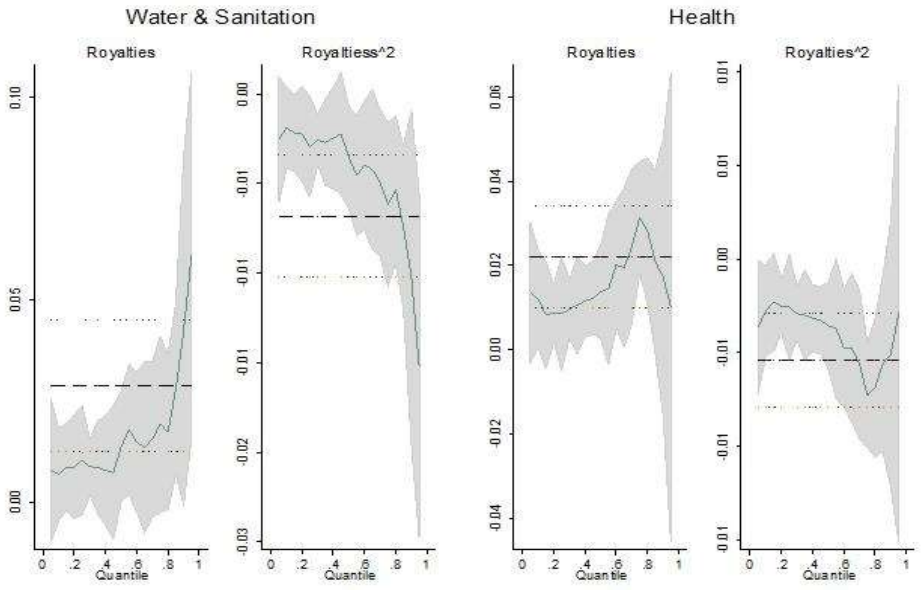
*** p<0.01, ** p<0.05, * p<0.1

C. Quantile regression analysis

Finally, we use quantile regression (QR) in order to identify heterogeneous responses to royalty payments over the entire distribution of efficiency scores. Using our preferred specification, Figure 7 displays the coefficients of interest and their respective 95% confidence intervals, along

with the OLS coefficients. While some of the coefficients are estimated with less precision, the impact of royalty payments seems larger for the most efficient municipalities.

Figure 7 - Quantile regression coefficients



3.3. Revenue windfalls and corruption

Our last empirical exercise tests whether levels of corruption vary with the size of the fiscal windfall. For this purpose, we used data on irregularities on contracts financed with direct royalty payments, which is available for around half of the municipalities in the sample. We used two different indicators of corruption as the dependent variable: 1) the percentage of the value of contracts financed with direct royalties subject to irregularities between 2009 and 2011 (columns 1 to 4) and; 2) the number of irregularities in contracts financed with direct royalty payments between 2009 and 2011 (columns 5 to 8). The main independent variable is royalty payments per capita (in logs). As controls we use expenditures per capita (in logs), transfers per capita (also in logs), tax revenue per capita (logs), percentage of urban population, NBI and the margin of victory (measured as the difference in vote shares between the winner and runner-up).[21]

Table 5 presents the results from TOBIT and OLS regressions for models 1 to 4 and 5 to 8 respectively. Department fixed effects are included in specifications 4 and 8, to control for

[21] All the variables enter as averages for the period 2009-11.

potential differences in corruption across municipalities due to geographical and institutional differences not represented by the variables in the model.

Table 5 - Determinants of the incidence and size of irregularities (Tobit and OLS regressions)

	% of royalty payments subject to irregularities (Tobit)				Number of irregularities (OLS)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ROYALTIES	-6.446***	-4.066***	-3.899***	-4.065***	-10.770***	-9.878***	-9.819***	-10.251***
	(0.962)	(1.003)	(1.127)	(1.336)	(1.170)	(1.021)	(1.051)	(1.352)
ROYALTIES^2	1.586***	1.001***	0.953***	1.023***	2.581***	2.317***	2.287***	2.463***
	(0.200)	(0.209)	(0.237)	(0.279)	(0.250)	(0.236)	(0.242)	(0.323)
EXPENDITURES		25.270***	25.156***	21.032***		15.481*	16.601**	14.054
		(7.539)	(7.361)	(6.304)		(7.979)	(8.012)	(9.965)
TRANSFERS		-24.772***	-25.805***	-20.253***		-24.106***	-24.268***	-19.995**
		(5.615)	(6.227)	(4.920)		(6.408)	(6.810)	(8.085)
TAX REVENUES		-2.951	-1.478	1.951		-1.209	-0.505	6.141
		(2.128)	(2.246)	(2.060)		(3.021)	(3.055)	(5.663)
NBI			0.058	0.062*			0.072**	0.058
			(0.039)	(0.034)			(0.030)	(0.039)
% OF URBAN POPULATION			0.017	0.007			0.072*	0.036
			(0.028)	(0.024)			(0.037)	(0.041)
MARGIN OF VICTORY			1.946	1.459			3.943	1.400
			(3.686)	(3.428)			(4.064)	(4.510)
Departament FE?	N	N	N	Y	N	N	N	Y
Observations	549	548	548	548	549	548	548	548
R-squared					0.310	0.344	0.354	0.428

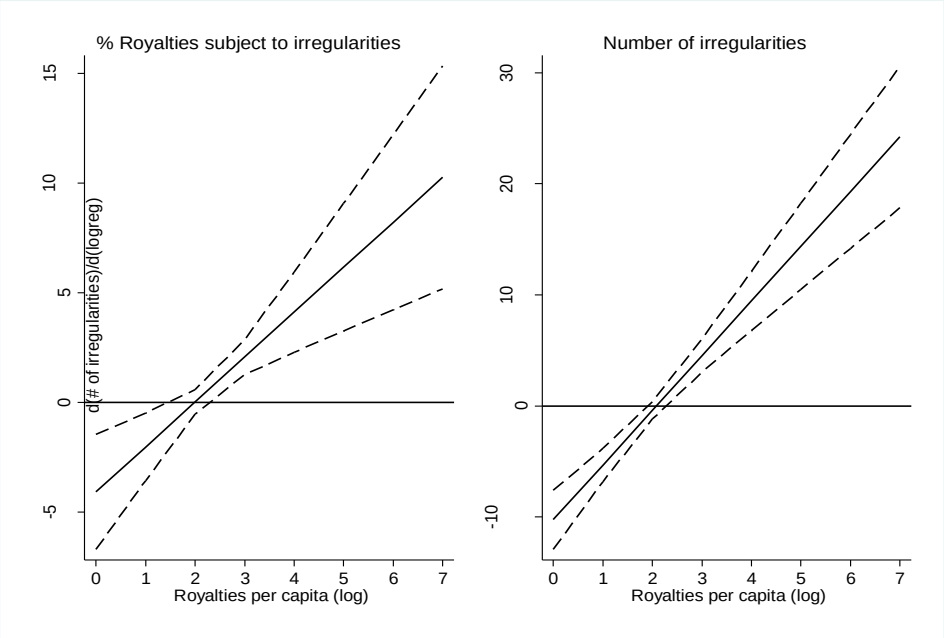
Robust standard errors in parentheses

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

While the non-monotonic relationship is evident once again, an increase in royalty payments would lead to an increase in corruption for most municipalities. For municipalities receiving modest amounts of fiscal windfalls, an increase in royalty payments up to reaching 96 pesos per capita seems to decrease corruption, measured as the percentage of the value of contracts financed with direct royalties subject to irregularities. In the same way, an increase in royalty payments up to reaching 120 pesos per capita reduces the number of irregularities in contracts financed with royalty payments. However, passed these thresholds, an increase on the size of the fiscal windfall is associated with increases in the levels of corruption. In fact, an increase in the amount of royalty payments per capita received is associated with an increase in the levels of corruption for almost 90 percent of the recipients of direct royalty payments. To give an idea of the impact of this effect, for the average municipality (receiving around $148,500 pesos per capita), a standard deviation increase in the amount of royalties per capita received is associated

with a 4.26% increase in the value of contracts subject to irregularities and with an increase of 10% in the number of irregularities. Figure 8 presents the marginal effects from Models 4 and 8.

Figure 8 - Marginal effects of royalties on incidence of corruption, with 95% confidence intervals



The economic impact of natural resource windfalls is almost as big as an increase in expenditures, for which a standard deviation increase from the average is associated with a 5.56 percent increase in the value of contracts subject to irregularities), and larger than a standard deviation increase on poverty levels, which is associated with just a 0.02 percent increase in the value of contracts subject to irregularities.

Conclusions

Taking advantage of a dramatic increase in oil and coal royalty payments transferred to some Colombian municipalities during the 2000s, and using disaggregated public finance data, this paper looks at the impact of revenue windfalls on the size and composition of local budgets, the efficiency of public good provision, and the incidence of corruption. We find that while fiscal windfalls boost government expenditures across the board, the efficiency of public spending at the local level tends to decrease with the size of the windfall shock, although in a non-monotonic fashion. In contrast, municipal own tax revenue sources are associated with higher efficiency scores. Moreover, an increase in windfall revenue raises the incidence of local corruption. Overall, our empirical findings point to the existence of a subnational resource curse, that is, a negative impact of windfall revenue on government performance (efficiency, corruption), paralleling subnational level evidence from other countries in Latin America such as Brazil (Brollo et al 2013; Caselli and Michaels 2013; Ferraz and Monteiro 2012) and Peru (Maldonado 2014; Arreaza and Reuter 2012).

In general, we find that using fiscal windfalls in an efficient and clean manner cannot be taken for granted at the local level. Thus, future research should provide a more detailed analysis of the impact of resource booms on local political behavior and its implications in terms of service delivery, the quality of public spending, and the probity of elected officials. In particular, it would be useful to consider the effects of revenue windfall shocks on reelection outcomes, political selection, and the instruments politicians use to affect these outcomes, such as service delivery and the provision of public (vs. particularistic/clientelistic) goods.[22] Along these lines, it remains crucial to uncover particular conditions under which politicians will have incentives to use windfall revenues efficiently, such as levels of electoral competition, or the presence of institutional constraints that limit discretion over its use. The identification of these conditional relationships or mechanisms is a necessary first step to understand variation in outcomes, detect differential behavior, and thus, provide sound policy advice.

Finally, it is important to note that the New General System of Royalties (*Sistema General de Regalías*-SGR) launched in 2012 is intended to overcome some of the problems addressed in this paper (in particular, inefficiency and incidence of corruption). The new governance structure redistributes royalty transfers among a wider set of subnational

[22] Recent analysis along these lines includes Ferraz and Monteiro (2012) and Maldonado (2013).

governments, addresses territorial equity concerns by allocating the SGR budget based on criteria such as population and relative poverty, and puts in place institutional mechanisms that are supposed to enhance the quality of public investments funded through the SGR at the subnational level. Thus, evaluating the extent to which the intended policy objectives of the SGR have been achieved is an important area for future research.

Appendices

Appendix A. methodology for the distribution of royalty payments from the FNR

Article 13, Decree 1747 of 1995		CONPES 3170 OF 2002/Resolution 419 of 2005		CONPES 3523 of 2008/Resolution 757 of 2008	
Criteria	**%**	**Criteria**	**%**	**Criteria**	**%**
NBI	No percentages assigned	Composite Index of Development	20%	NBI	30%
Economic capacity					
Population density		Population density	20%	Population adjusted by dispersion	30%
Harmonic development according to National Development Plan		Population projections	20%	Amount of specific allocations from FNR	30%
Environmental, social and economic impact of the project		Relationship between royalties of FNR specifically allocated and total revenues	20%	Balance from resources from production in excess	10%
Participation of the Regional Corporation of Economic and Social Planification (CORPES)				Having been a FNR beneficiary during tha period or the previous one.	-10%
Direct Royalties received		Relationship between direct royalties and total revenues	20%	Project presented by two or more subnational entities	10%

Appendix B. The New System (2012 on)

Under the new system (called Royalties General System, SGR), resources from royalties are distributed to municipalities and departments through several separate funds. A maximum of 15.34% of the total SGR are directly distributed to "producer" subnationals (with a transitory regime which allocated a 34.50% in 2012, and a 22% for the period 2013-2014).

In particular, the distribution of resources from royalties is as follows:

Allocation of Funds	**Share**	**Beneficiaries**
Oil Oversight and Mapping	**2.0%**	n/a
SGR Operational Costs	**1.3%**	n/a
Territorial Pension Funds (FONPET)	**10.0%**	Departments &Municipalities

Science, Innovation and Technology Fund	**10.0%**	Departments
Savings and Stabilization Fund	**30%** (max)	Departments
Remaining Funds	**46.70%** (min)	Departments &Municipalities
o/w Direct Royalty Payments	*20.0%*	Departments &Municipalities
o/w Regional Development Fund	*32.0%*	Departments
o/w Regional Compensation Fund (Regional Projects)	*28.8%*	Departments
o/w Regional Compensation Fund (Local Projects)	*19.2%*	Municipalities

Appendix C. The determinants of expenditure efficiency using DEA (IV 2SLS with coal as instrument)

	Efficiency scores: water quality index				Efficiency scores: infant mortality rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ROYALTIES	2.341	-0.256	-0.225	-0.535	0.919	0.587	0.663	10.582
	(8.677)	(0.476)	(0.495)	(0.866)	(1.007)	(0.369)	(0.451)	(196.081)
ROYALTIES^2	-0.431	0.047	0.042	0.106	-0.170	-0.114	-0.130	-2.125
	(1.583)	(0.092)	(0.096)	(0.174)	(0.185)	(0.071)	(0.087)	(39.367)
EXPENDITURES		-1.155	-1.036	-1.767		1.013	1.169	22.306
		(1.120)	(1.125)	(1.814)		(0.830)	(0.996)	(417.262)
TRANSFERS		0.045	0.106	0.527		-0.778**	-0.897*	-11.927
		(0.513)	(0.559)	(0.892)		(0.393)	(0.526)	(216.806)
TAX REVENUES		0.243	0.155	0.237		-0.154	-0.133	-3.122
		(0.256)	(0.196)	(0.221)		(0.193)	(0.187)	(59.432)
% URBAN POPULATION			0.002***	0.003**			0.000	-0.017
			(0.000)	(0.001)			(0.001)	(0.338)
NBI			-0.001	-0.001			0.002	0.016
			(0.002)	(0.002)			(0.002)	(0.295)
MARGIN OF VICTORY			-0.077	-0.174			0.102	2.917
			(0.101)	(0.272)			(0.110)	(54.998)
Constant	-1.391	5.768**	5.093*	6.904	-0.257	-0.743	-1.227	-56.364
	(6.426)	(2.766)	(2.896)	(5.399)	(0.743)	(2.035)	(2.386)	(1,090.249)
Department FE?	N	N	N	Y	N	N	N	Y
				First stage results for royalties				
Value of coal production per capita	0.162***	0.123***	0.131***	0.158***	0.145***	0.118***	0.130***	0.164***
	(0.024)	(0.022)	(0.023)	(0.028)	(0.023)	(0.023)	(0.023)	(0.028)
R-squared	0.025	0.110	0.145	0.286	0.019	0.098	0.139	0.285
Cragg-Donald Wald F statistic	0.67	0.634	0.488	0.526	0.593	2.16	1.921	0.003
Kleibergen-Paap F statistic	0.68	0.706	0.528	0.504	0.78	2.454	2.077	0.003
Observations	1,045	1,045	1,045	1,045	1,076	1,076	1,076	1,076

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

Figure A 1 - Volatility of municipal royalty payments, transfers and tax revenues by department (coefficient of variation, %)

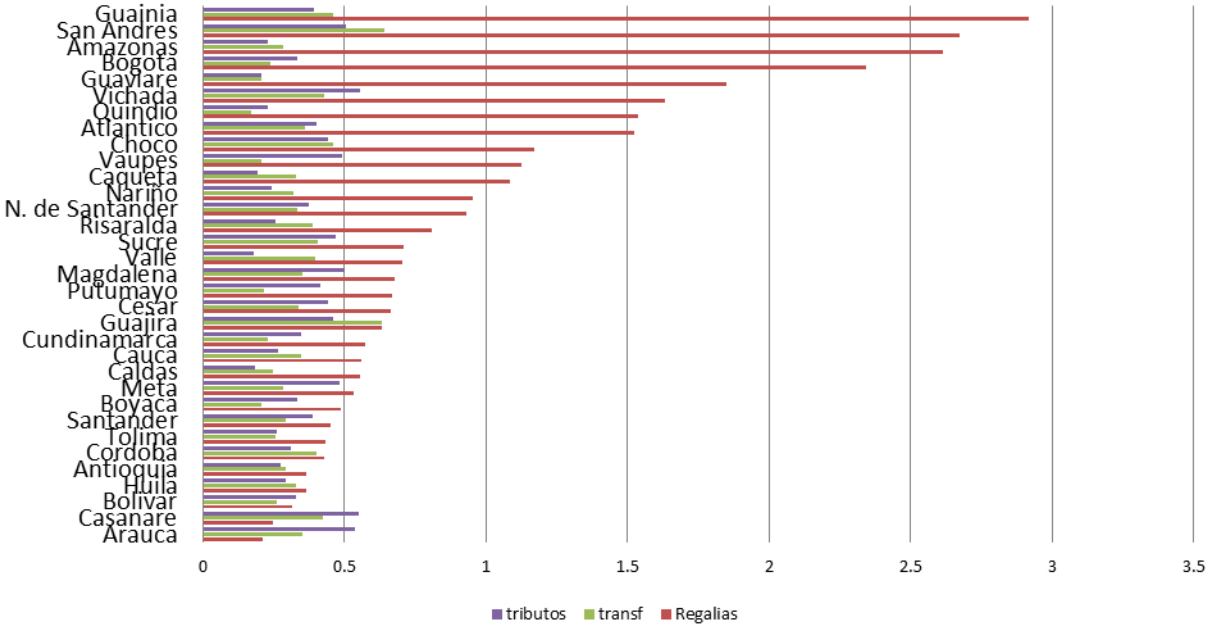
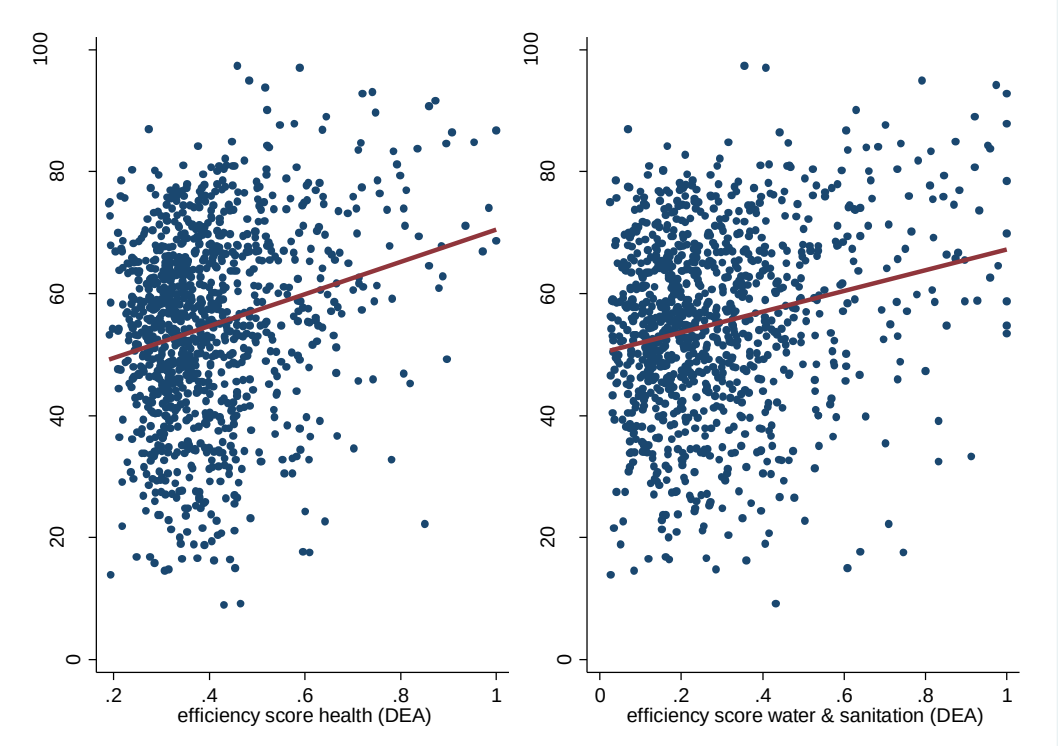
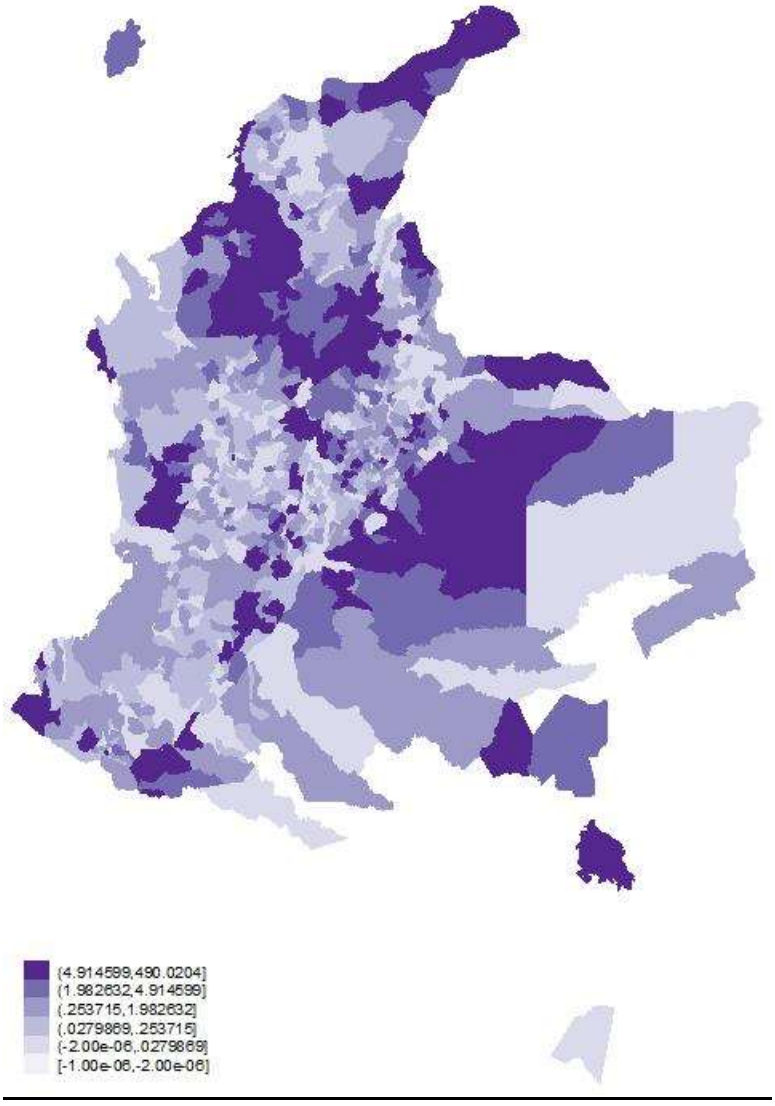


Figure A 2-Correlation between DNP and efficiency scores



Map 1 - Distribution of royalty payments in Colombia (average 2004-2011)



References

Ardanaz, M. 2014. Fiscal Windfalls, transparency, and the efficiency of public good provision: evidence from Brazilian local governments. In *Transparent Governance in an Age of Abundance: Experiences from the Extractive Industries in Latin America and the Caribbean*. J.C. Vieyra and M. Masson (editors). Inter-American Development Bank

Arreaza, A., and A. Reuter. 2012. Can a Mining Windfall Improve Welfare? Evidence from Perú with municipal level data, CAF.

Bonet, J. y J. Urrego (2014) El Sistema General de Regalías: ¿mejoró, empeoró o quedó igual? Documentos de trabajo sobre economía regional, Cartagena: Banco de la República

Brollo, F., T. Nannicini, R. Perotti, and G. Tabellini. 2013. The political resource curse. *American Economic Review*

Brosio, G., and J.P. Jimenez. 2012. The intergovernmental allocation of revenue from natural resources: finding a balance between centripetal and centrifugal pressure. In *Decentralization and Reform in Latin America*. Edward Elgar.

Caselli, F. and G. Micheals. 2013. "Do oil windfalls improve living standards? Evidence from Brazil." *American Economic Journal: Applied Economics*, 5, 208-238.

Caselli, F. and T. Cunningham. 2009. "Leader behavior and the natural resource curse". *Oxford Economic Papers*, 61, 628-650.

DNP (2014) Evaluación del desempeño integral de los municipios y distritos, Vigencia 2013. Bogotá.

DNP (2012): "Una evaluación del impacto de las regalías directas y fondo nacional de regalías", Departamento Nacional de Planeación.

DNP (2007) "Las Regalías en Colombia" (Actualización de la Cartilla). Dirección General de Regalías-DNP. November 2007.

Dube, O. and J. Vargas. 2013. "Commodity price shocks and civil conflict: Evidence from Colombia. *Review of Economic Studies*

ECLAC (2015) El impacto fiscal de los recursos naturales no renovables en los paises de America Latina. En *Panorama fiscal de America Latina y el Caribe*

Ferraz, C. and J. Monteiro. 2012. Does oil make leader unaccountable? Evidence from Brazil's offshore oil boom, PUC RIO. Mimeo.

Gadenne, L. 2013. Tax Me, But Spend Wisely : The Political Economy of Taxes, Theory and Evidence from Brazilian Local Governments. Paris School of Economics. Mimeo.

IMF (2014) 'Macroeconomic Policy Frameworks for Resource-Rich Developing Countries',

International Monetary Fund.

Karl, T. 1997. *The Paradox of Plenty: Oil Booms and Petro States*. University of California Press. Berkeley.

Loayza, N., A. Mier y Teran, J. Rigolini. 2013. Poverty, Inequality, and the Local Natural Resource Curse. World Bank.

Maldonado, S. 2014. The political effects of resource abundance: evidence from Perú. University of California, Berkeley. Mimeo.

Martinez, L. (2014) "Sources of Revenue and Government Performance: Theory and Evidence from Colombia. LSE.

Morgandi, Matteo. 2008. Extractive Industries Revenues Distribution at the Sub-National Level. Revenue Watch Institute. Mimeo.

Perry, G., y M. Olivera (2009). El impacto del petróleo y la minería en el desarrollo regional y local en Colombia.

OECD. 2014. *Territorial Reviews: Colombia*. OECD. Paris.

Robinson, J.A., Torvik, R., and Verdier, T. (2006) Political foundations of the resource curse, *Journal of Development Economics*, 79, 447–68.

Ross, M. 1999. "The political economy of the resource curse." *World Politics*, 53, 325-361.

Sachs, J. and A. Warner. 1995. "Natural resource abundance and economic growth." Unpublished manuscript. Harvard University.

Sanguinetti, P. 2012. Canon minero y decisiones fiscales subnacionales en el Perú. (CAF Working Paper N°2010/01). Caracas: CAF.

Viale, C. y E. Cruzado. 2012. La distribucion de la renta de las Industrias Extractivas a los Gobiernos Subnacionales en Ame rica Latina. Revenue Watch, Mimeo.

World Bank (2009) Colombia Decentralization. Options and Incentives for Efficiency. Volumes I & II. The World Bank. August 2009.