Sources of Revenue and Government Performance: Evidence from Colombia

Luis R. Martínez[*]

London School of Economics and Political Science

JOB MARKET PAPER

January 11 2016

Abstract

If government revenue is not coming out of their pockets, voters may be uninformed about it or uninterested in what happens to it, contributing to low accountability and poor governance. The present paper provides empirical evidence on the positive relationship between taxation and governance by comparing the effects of increases in internally-raised tax revenue and in royalties from the extraction of oil on local public good provision in a panel of Colombian municipalities. I find that an increase in property tax revenue, occurring as a result of an exogenous cadastral update, has a positive effect on several basic public services in the areas of education, health and water. These effects are at least ten times larger than the effects of an equivalent increase in oil royalties, obtained as a consequence of exogenous fluctuations in the world price of oil. I find no evidence that oil royalties contribute to improvements in public service provision, despite being earmarked for this purpose. Differences in the timing and in the sectoral allocation of spending across sources are unable to explain the results. I use novel data on disciplinary prosecutions to show that additional oil royalties increase the probability that the mayor and other local public officials are prosecuted, found guilty, and removed from office. I also provide suggestive evidence on the positive effect of taxation on citizen demands regarding public services. These results indicate that accountability is crucial for the responsible management of public funds and that taxation is an effective way of achieving the necessary citizen involvement in public affairs.

Visit `http://sites.google.com/site/lrmartineza` for the latest version.

[*] l.r.martinez@lse.ac.uk. Department of Economics and STICERD.

I would like to thank Gerard Padró i Miquel for his support and advice throughout this project. I am also grateful to Fernando Aragon, Oriana Bandiera, Pranab Bardhan, Tim Besley, Florian Blum, Gharad Bryan, Francesco Caselli, Jonathan Colmer, Andrew Ellis, Miguel Espinosa, Claudio Ferraz, Greg Fischer, Lucie Gadenne, Maitreesh Ghatak, Anders Jensen, Dean Karlan, Camille Landais, Gilat Levy, María del Pilar López, Roger Myerson, Imran Rasul, Nelson Ruiz, Fabio Sánchez, Johannes Spinnewijn, Munir Squires, Guo Xu and to seminar/conference participants at LSE, EDEPO (UCL), PACDEV 2015, LACEA-PEG 2015, ZEW PF 2015, RES Jr. 2015, IIPF 2015, EEA 2015, OXDEV 2015, Frontiers of Urban Economics 2015 and NEUDC 2015 for comments and suggestions. I would also like to thank Ivo Bischoff, Massimiliano Piacenza, Carlos Scartascini, Ju Qiu and Xiao Yu Wang for their thoughtful discussions. I thank Mario Martinez at Instituto Geográfico Agustín Codazzi for answering all my questions on cadastral updating and I also thank Adriana Camacho, Juan Camilo Herrera, Oskar Nupia, Mónica Pachón, Fabio Sánchez, Rafael Santos and Ana María Tribín for generously sharing data with me. All remaining errors are mine.

1. Introduction

Inadequate provision of public goods is an obstacle to development in most low-income countries (World Bank, 2004; Besley and Ghatak, 2006). A frequent way of addressing this problem in recent decades has been through the devolution of expenditure responsibilities to local governments (Gadenne and Singhal, 2014). These reforms have tried to exploit the increased accountability of local public officials and they have had widespread support from international organizations such as the World Bank (2000).[1] However, despite the strong incentives that local democracy appears to provide for good governance, this recent wave of decentralization has met with only limited success so far.[2]

It is true, though, that local governments in developing countries depend to a large extent on external sources of revenue, such as transfers from higher levels of government and natural resource rents. Several well-identified studies have documented how increases in revenue from these sources appear to have a very low impact on public good provision, often leading to a worsening of corruption instead.[3] It thus seems plausible that the way in which local public finances are organized is contributing to the suboptimal provision of public goods across the developing world. If revenue is not coming out of their pockets, voters may be uninformed about it or uninterested in what happens to it, failing to hold the government accountable as a result. However, without the benchmark provided by tax revenue, we cannot rule out that the poor governance associated with additional resources is simply indicating that these governments have low technical capacity or are the victims of widespread corruption, no matter what the source of revenue is.

In the present paper, I test the hypothesis that internally-raised tax revenue has a larger effect on the provision of public goods than revenue from an external or unearned source. For this purpose, I compare the effects of increases in local tax revenue and in royalties from the extraction of oil on the provision of public goods in a panel of Colombian municipalities. I show that local tax revenue has a much larger impact than oil royalties on several indicators of public good provision. I argue that this difference is driven by the opposite effects of tax revenue and external revenue on the misbehavior of local politicians and I use novel data on disciplinary prosecutions to provide supporting evidence.

A comparison of this nature faces several challenges. We must first find a setting where local governments have access to both tax and non-tax sources of revenue and are responsible

[1]In the words of Bardhan (2002, p.185), "In matters of governance, decentralization is the rage."

[2]See Faguet (2014) and Mookherjee (2015) for recent reviews on decentralization. For evidence on local democracy in developing countries, see Ferraz and Finan (2011); De Janvry et al. (2012); Martínez-Bravo et al. (2014); Fujiwara (2015).

[3]See Fisman and Gatti (2002); Reinikka and Svensson (2004); Vicente (2010); Caselli and Michaels (2013); Brollo et al. (2013); Litschig and Morrison (2013); Maldonado (2014); Olsson and Valsecchi (2014).

for the provision of public goods. We must also have access to plausible sources of variation not only in external revenue, which the previous literature has accomplished with some success, but also in internally-raised tax revenue, which is a more daunting task and has seldom been done before. Finally, our comparison must account for the fact that revenue can be used for many different purposes, so a careful choice of outcomes is needed. Colombia meets all these conditions.

Colombian municipalities are responsible for the provision of basic public services and finance them with a mix of local taxes, transfers from the central government and royalties from the extraction of natural resources. The royalties received by resource-producing municipalities are formula-determined and amount to a fixed share of the market value (at world prices) of the extracted resources. Oil is the most important source of royalties in Colombia but the country is a small player in the oil market and is unable to affect world prices.[4] Hence, I exploit time variation in the world price of oil between 2005 and 2011, together with cross-sectional variation in oil intensity (using average municipal oil royalties between 2000 and 2004) to estimate the effect of royalties on local public goods.

The municipal expenditure of natural resource royalties is heavily regulated. Royalties must be spent on public services in the areas of education, health and water until targets are met for five specific indicators. I show that target achievement is low among oil royalty recipients at the start of the sample period and that the earmarking rules were followed, making these indicators the best place to look for the impact of royalties on public goods and services. The four indicators for which yearly data is available are my main outcomes of interest: the net enrolment rate in basic education, the infant mortality rate, the percentage of poor population with subsidized health insurance and a water quality index.

I compare the effect of oil royalties on the indicators above to that of property tax revenue, the main local tax in Colombia. The base of the property tax is the value of the properties in the municipality's official property register or cadastre. Each year the national geography institute run by the central government updates the cadastre of some municipalities and reassesses the value of the included properties, which leads to a sharp increase in property tax revenue. I argue that the timing of these updates is plausibly exogenous. For this purpose, I provide evidence on the municipalities' limited ability to manipulate the timing of their update and I show that it is mainly determined by the supply of updates from the geography institute. Furthermore, given that municipalities have discretion over the expenditure of tax revenue, a comparison based on the outcomes for which natural resource royalties are earmarked is likely to be biased in favor of this latter source.

[4]In the appendix I provide very similar results for coal, which is the second most important source of royalties. Together, oil and coal account for over 90 % of royalties in the period 2005-2011.

The estimates from an instrumental variables model with municipality and department-year fixed effects indicate that an increase in property tax revenue has a positive and statistically significant effect on educational enrolment and on a water quality index. Additional property tax revenue also increases the probability of achieving universal coverage of poor population with subsidized health insurance. These effects are at least one order of magnitude greater than (and statistically different from) the effects of an increase in oil royalties of the same size. In fact, I find a striking result: the effect of additional royalties is basically zero for all outcomes and the point estimates are negative in several cases.

One potential concern regarding these findings is that different types of municipality may raise revenue from different sources. However, I show that the positive effects of cadastral updating and property tax revenue extend to oil-royalty recipients. Another potential problem is that differences in expenditure could arise because cadastral updates lead to a stable increase in tax revenue while oil price shocks lead to temporary fluctuations in royalties. To address this concern, I show that differences in the propensity to spend out of the two sources (based on a higher cautiousness when spending oil windfalls) cannot explain the results. I also show that there is no evidence of improvement in any indicator in the medium-run (seven years) for oil-royalty recipients, which indicates that royalties are not being spent on projects of a larger scale whose returns require more time to materialize. I find that additional revenue from either source is channeled almost exclusively into investment in fixed capital but that only tax revenue leads to an increase in the number of schools in the municipality.

I argue that the heterogeneous effects of tax revenue and oil royalties on public goods are driven by harder-to-observe differences in the quality of expenditure, and more generally in the competence of local governments, according to the source of funding. Using newly collected data on the disciplinary prosecution of local public officials in Colombia I find that an increase in oil royalties leads to a statistically significant increase in the probability that the municipal mayor and top members of staff are prosecuted, found guilty and removed from office and barred from politics by a national watchdog agency. Increases in property tax revenue, on the other hand, appear to reduce the probability of these events, although the difference is not statistically significant.

The findings of this paper are consistent with the idea that taxation makes voters either more able or more willing to hold the government accountable (Paler, 2013). In the theoretical appendix, I provide a model of political agency with career concerns that illustrates how both information-based and preference-based mechanisms can explain the results from the empirical exercise. I provide suggestive evidence on the heterogeneous response of residents to increases in taxation relative to external revenue using data on social mobilizations. I find that property tax revenue has a positive effect on the probability that a protest related to local public services takes place in the municipality, while oil royalties have a negative effect. Again, the difference is not statistically significant.

The idea that taxation improves governance is not new. It can be found in comparative papers on the development of modern Europe (North and Weingast, 1989) or on the 'rentier states' of the Middle East (Mahdavy, 1970; Beblawi, 1990; Ross, 2001). In development economics, this idea is present in discussions on foreign aid (Bauer, 1972; Easterly, 2006; Collier, 2006; Deaton, 2013) and on state capacity (Besley and Persson, 2011, 2013, 2014). In public economics, it is at the core of the 'second generation' approach to fiscal federalism (Oates, 2005; Weingast, 2009) and it is related to the idea of 'fiscal illusion' (Dollery and Worthington, 1996). However, there is only limited empirical evidence on this topic.

Two recent papers have studied the heterogeneous effects of tax revenue and external revenue on public good provision, with mixed findings. Borge et al. (2015) show that additional rents from hydro-power production reduce the efficiency of public expenditure less than increases in other revenue in Norwegian municipalities. In the most closely related contribution to the present paper, Gadenne (2015) reports improvements in educational infrastructure for Brazilian municipalities that enroll in a tax modernization program, while higher transfers have no effect. The main challenge that this line of research still faces is coming up with plausibly exogenous sources of variation in tax revenue, as changes in tax bases and tax rates are likely to be endogenous to political and economic factors that can potentially affect outcomes of interest.

The present paper introduces cadastral updates as a plausibly exogenous source of variation in local tax revenue.[5] These updates lead to an increase in tax revenue that is not correlated to changes in political or economic conditions, nor in tax administration or structure. I observe cadastral updates for 60 % of municipalities over a five-year period, which ensures the representativeness of the results among Colombian municipalities and allows for a common support with oil-royalty recipients. I exploit the earmarking of natural resource royalties to target the comparison across sources of revenue and I look not only at educational infrastructure, but also at policy outcomes in the areas of education, health and water. The present paper also contributes to the existing literature by using novel data on disciplinary prosecutions to illustrate the heterogeneous effects of tax revenue and external revenue on local politicians' misbehavior.

The present paper's main contribution is to the empirical literature studying the relations-

[5]Sánchez and Pachón (2013) use an IV strategy based on cadastral depreciation and find that educational enrolment and water quality improve in Colombian municipalities that collect more taxes. I build on their work by providing the necessary evidence on the exogeneity of the timing of cadastral updates. Additionally, while Sánchez and Pachón (2013) focus exclusively on tax revenue, I answer a different question related to the heterogeneous effects of tax revenue and external revenue.

hip between public finance and governance.[6] It is also related to to the empirical literature that uses sub-national data to study the effects of natural resource rents.[7] The theoretical model I develop also complements previous contributions on the political resource curse by exploring the heterogeneous political effects of resource rents relative to tax revenue.[8] The paper contributes as well to the 'second generation' literature on fiscal federalism by providing evidence on the importance of local fiscal incentives.[9]

The rest of this paper is organized as follows. Section 2 provides background information on the setting for the empirical exercise. Section 3 presents the data and discusses the empirical strategy. The main results on public goods and the robustness checks are shown in section 4. Evidence from disciplinary prosecutions is provided in section 5. In Section 6 I discuss the findings and the underlying mechanisms. Section 7 concludes.

2. Local Public Finance and Public Service Provision in Colombia

There are two levels of sub-national government in Colombia: 1100 municipalities are grouped into 32 departments (similarly to US states and counties). The top municipal authority is the mayor, who serves a four-year term without the possibility of re-election. The municipal council, which is elected at the same time as the mayor, must approve the mayor's plan of government as well as the annual budget and must also supervise their execution.

Following a decentralization reform in the early 1990s, municipalities and departments became jointly responsible for the provision of basic public services in the areas of education, health, drinking water and sanitation. The main source of funding for related expenditures is a system of earmarked and formula-determined transfers from the central government called "Sistema General de Participaciones" (SGP), which accounts on average for 63 % of

[6] Zhuravskaya (2000) documents the negative effects of transfer offsets to increases in tax revenue in Russian cities. Ross (2004) reports cross-country evidence on the link between taxation and democracy. Paler (2013) and Martin (2014) provide experimental evidence on people's higher willingness to hold the government accountable when they are taxed. Borge and Rattsø (2008) and Sánchez and Pachón (2013) show that property taxes improve the efficiency and amount of public services in Norway and Colombia, respectively. Casaburi and Troiano (2015) find that cadastral registration has positive effects on local governance in Italian municipalities.

[7] See Caselli and Michaels (2013); Maldonado (2014); Ferraz and Monteiro (2014); Olsson and Valsecchi (2014); Herrera (2014); Carreri and Dube (2015).

[8] See Caselli (2006); Mehlum et al. (2006); Robinson et al. (2006); Caselli and Cunningham (2009); Brollo et al. (2013); Matsen et al. (2015)

[9] See Bardhan (2002); Oates (2005); Bardhan and Mookherjee (2006); Faguet and Sánchez (2008, 2014); Weingast (2009). Glaeser (1996) and Hoxby (1999) explore the potential of the property tax to act as a disciplining device for local governments.

municipal total revenue.[10]

Taxes are the second most important source of revenue and contribute on average with 44 % of current receipts and 13 % of total revenue. The main local taxes (and their average shares of tax revenue) are the property tax (34 %), the business tax (17 %) and the petrol surcharge (22 %).[11] The property tax is the most important source of tax revenue for slightly more than one half of municipalities, but its relative importance decreases with population size (Núñez, 2005).[12] Aggregate property tax revenue has been relatively stable since 2000 at around 0.5 % of GDP (Sánchez and España, 2013).

Municipalities have discretion over the expenditure of property tax revenue, except for a fixed share that they are required to transfer to an environmental agency.[13] Municipalities can use own revenues (including tax revenue) for the provision of various public services. Any municipality can supply funding for the provision of education and can also invest in educational infrastructure or school equipment. Regarding health-related expenses, municipalities can provide subsidized health insurance to the population classified as poor by the national government's proxy-means-testing targeting system (SISBEN). Municipal governments can also use own revenues for public health initiatives such as vaccination campaigns (vaccines are provided at zero cost by the central government). In the case of water and sanitation, municipalities can invest their own resources in infrastructure or can provide subsidized access to the poor.

The property tax is levied on the cadastral value of all real estate in the municipality. The cadastre or land register is the official record of the physical and economic characteristics of all properties in a municipality. The cadastre of all municipalities in the country (except for Bogotá, Medellín, Cali and the department of Antioquia) is managed by the National

[10]SGP transfers must be kept in a separate account from other sources of revenue. Municipal autonomy over the expenditure of these transfers and over the administration of public services varies across municipalities and across sectors, with the specific responsibilities of each level of government being somewhat blurry (Alesina et al., 2005). After an additional reform in 2001, municipalities "certified" by the Ministries of Education or Health started to directly manage the transfers earmarked for these areas (Cortés, 2010; Brutti, 2015). Otherwise, transfers are managed by the departmental government. Certified municipalities also have greater autonomy in the management of the local education and health systems. However, the provision of health services is highly regulated, even for certified municipalities, and must take place through special firms called "Empresas Sociales del Estado" (ESE). In the case of water and sanitation, municipalities manage the share of transfers earmarked for this purpose unless they are "de-certified" by the Superintendent for Public Services.

[11]Other local taxes include those for car registration and for the display of billboards and banners.

[12]Glaeser (2013) reports that local public finances in the US are not very different, with intra-government transfers and property taxes being the most important sources of revenue for all but the largest cities. Gadenne and Singhal (2014) show that dependence on external revenue is greater for local governments in developing countries.

[13]There are 34 such agencies in the country. Some cover a handful of municipalities while others cover multiple departments. The percentage transferred must be between 15 % and 25 % of property tax revenue.

geography institute, *Instituto Geográfico Agustín Codazzi* (IGAC), an agency run by the central government. As part of its duties, IGAC periodically updates the cadastres under its control. Cadastral updates mainly involve reassessing existing properties but also, to a much lesser extent, incorporating previously unregistered properties to the cadastre.[14]

The third most important source of local revenue is royalties from the extraction of natural resources. The main source of royalties between 2005 and 2011 was the extraction of oil (69 % of the total), followed by coal (23 %).[15] Royalties are paid by firms to the central government according to a set of fixed resource-specific formulae of the form

$$\text{royalty} = \text{output} \times \text{world price (USD)} \times \text{exchange rate (COP/USD)} \times \text{royalty rate}$$

In the case of oil, between 60 % and 84 % of these royalty payments are transferred by the central government to the municipalities and departments where oil is extracted, with the marginal royalty transfer rate decreasing in output. Another 8 % of the total is distributed among the port municipalities from where oil is shipped and the remaining share (between 8 % and 32 %) is allocated to investment projects in non-producing areas.[16] The total amount of royalties received by oil-producing and port municipalities (18 % of the country) between 2005 and 2011 amounted to 3.5 billion USD. On average, royalties represent 23 % of total revenue for this set of municipalities. A reform in 2012 significantly modified the way in which royalties are distributed, but data availability prevents me from exploiting this source of variation.

By law, at least 75 % of royalties must be spent on education, health, drinking water and sanitation until specific targets are met for the specific set of indicators listed in Table 1. These indicators are the net enrolment rate in basic education (years 1-9, ages 6-14), the infant mortality rate, the percentage of poor population with subsidized health insurance and the percentages of population with access to clean water and sewerage, where water is only considered suitable for human consumption if it scores less than 5 in a water quality index ranging from 0 to 100. Columns 2 and 3 of Table 1 show that target achievement among oil-royalty recipients was low for all indicators at the start of the sample period. The rules governing the distribution and expenditure of royalties do not disincentivize target achievement, as municipalities keep receiving royalties once targets are met and can spend them on priority projects from the mayor's government plan.

In order to achieve the education target, royalties can be spent on education infrastructure, school equipment or transportation. They can only be used to directly finance the

[14] Iregui et al. (2003, 2004) and Sánchez and España (2013) provide further information on the property tax and on cadastral updating in Colombia.

[15] Royalties are also paid for the extraction of precious metals, gemstones, iron, copper, nickel and salt.

[16] The allocation rules are roughly similar for other natural resources.

provision of education if SGP transfers are shown to be insufficient. Royalty recipients can reduce infant mortality through public health policies or by setting up emergency health posts for common infant diseases. Royalties can also be used for expenditures related to water and sewerage projects, such as initial studies, designs and construction.

3. Empirical Strategy

I use panel data for 969 Colombian municipalities between 2005 and 2011 to test the hypothesis that tax revenue has a larger effect on public good provision than revenue from an external source. I exploit the timing of cadastral updates and the fluctuations in the world price of oil as sources of exogenous variation in local property tax revenue and in royalties from the extraction of oil, respectively, and I compare the effect that revenue from these two sources has on the local public goods for which royalties are earmarked. In the following subsections I explain the details of this empirical exercise. First, I introduce the data employed. Secondly, I present the outcomes of interest. Finally, I discuss the identification strategy.

3.1. Data

Data on municipal public finance comes from the yearly balance sheets reported by each municipality to the Office of the Comptroller General for the purpose of fiscal control. These balance sheets have disaggregated information on all sources of revenue, including tax revenue (by type of tax), transfers and royalties. Information on expenditure is also available in these balance sheets, disaggregated between current expenditure (operating costs) and investment. I express all money values in tens of thousands of 2004 Colombian Pesos (COP) per capita (unless otherwise stated), using the Consumer Price Index and population estimates from the National Statistical Agency, *Departamento Administrativo Nacional de Estadística* (DANE).

Data on the local public goods for which royalties are earmarked (Table 1) comes from various sources: the net enrolment rate in basic education and the infant mortality rate are provided by the Ministry of Education and DANE, respectively.[17] The source for the yearly percentage of poor population with access to subsidized health insurance is the Ministry of Health.[18] The water quality index, *Indice de Riesgo de la Calidad del Agua* (IRCA), is calculated by the National Health Institute, *Instituto Nacional de Salud* (INS). All indicators

[17]The net enrolment rate is calculated by dividing the number of children with ages 6 to 14 enrolled in school years 1 to 9 by the number of children in this age group. Since data on enrolment and data on population come from different sources, the resulting figure can actually exceed 100 %. I censor enrolment rates above 100 % but the results are robust to using the original data.

[18]Poor is defined as belonging to categories 1 or 2 of the Colombian proxy-means-testing system SISBEN.

are available at the municipality-year level for the period 2005-2011, except for the water quality index, which is only available since 2007. In the following section I explain why I choose these indicators as the main outcomes of interest.

IGAC has yearly data on the number of properties, the total property value and the year of the last cadastral update for both the urban and rural areas of each municipality under its supervision. Municipalities with their own cadastral agencies (Bogotá, Medellín, Cali and Antioquia department) are dropped from the sample. This leaves me with 969 municipalities (86 % of the total). In the empirical exercise I do not distinguish between urban and rural updates, but the results are robust to the exclusion of rural updates (available upon request).

Data on oil royalties comes from the state-owned Colombian oil company, *Ecopetrol*, for the period 2000-2003 and from the National Hydrocarbons Agency, *Agencia Nacional de Hidrocarburos* (ANH), for the period 2004-2011. I use the average petroleum spot price from the IMF's International Financial Statistics (IFS).

Summary statistics for the main variables employed in the paper are provided in Table 2. The average municipality has 30,000 inhabitants (the median is 13,000), of which 60 % live in rural areas.[19] The average levels of total revenue, property tax revenue and natural resource royalties are 540,000, 21,000 and 55,000 COP per capita, respectively. On average, municipalities experience fiscal deficits during the sample period, with total expenditure at 580,000 COP per capita. Most expenditure (almost 500,000 COP per capita) goes to investment.

3.2. Indicators of Local Public Good Provision

As mentioned above, Colombian law stipulates that at least 75 % of royalties must be spent on the improvement of basic public services until targets are met for the set of indicators listed in Table 1. The targets are displayed in column 1, while column 2 shows the average value of each indicator in 2005 (the first year for which data is available) among oil-royalty recipients. At the start of the sample, the average municipality receiving oil royalties does not meet any of the targets. Column 3 further shows that the percentage of oil-royalty recipients reaching each target is less than or equal to 30 % for all indicators except access to drinking water (62 %).

The low levels of compliance imply that the targets were binding constraints during the sample period and that royalties had to be spent on the improvement of the indicators in Table 1. Figure 1, which is based on administrative data on the expenditure of royalties for 2010 and 2011, shows that almost 80 % of royalties were allocated to the attainment of the

[19] However, Colombia is a predominantly urban country. In 2005, 45 % of the country's population lived in the 20 largest cities, where only 7 % of the population is considered rural.

targets, mainly in education and water. Even though royalties could crowd out own expenditure in the earmarked sectors, total investment in these sectors must rise with royalties (though not necessarily at the margin) since the ratio of royalties to own revenues among oil-royalty recipients is 1.58 on average during the sample period.

Hence, the indicators in Table 1 are the best place to look for the impact of natural resource royalties on public goods and I use them as the main outcomes of interest for the empirical exercise. Yearly municipality-level data is not available on the percentages of population with access to drinking water and sewerage, forcing me to leave these two indicators out of the analysis.[20] Therefore, the four main outcomes of interest are the net basic education enrolment rate, the infant mortality rate, the percentage of poor population with subsidized health insurance and the IRCA water quality index. Nevertheless, there is a strong cross-sectional correlation between the baseline score of the water quality index in 2007 and the values of the two omitted indicators from the 2005 population census, which suggests that the water quality index could potentially capture improvements in access to drinking water and sanitation.[21]

My choice of indicators of local public goods leads to a particularly stringent test because municipalities have full discretion over tax revenue while they are required to spend the vast majority of natural resource royalties on the outcomes of interest. The higher required propensity to spend revenue from royalties on these outcomes should lead to the effect of natural resource royalties being mechanically larger than the effect of tax revenue. Therefore, the comparison I carry out is biased, but the bias works against the hypothesis that I want to test.

An additional reason to study the four chosen indicators of local public good provision is because they are a valuable source of information on local living conditions. In fact, the specified targets are closely related to the attainment of some of the United Nations' Millenium Development Goals (MDG), such as achieving universal primary education, reducing under-five mortality by two thirds and halving the share of people without access to clean water and sanitation.

Panel E. in Table 2 provides summary statistics for the four main outcome variables, while Table A1 in the appendix uses data from the World Development Indicators (WDI) to compare Colombia's social indicators with those of eleven other Latin American countries around the start of the sample period.[22] This comparison reveals that the country was lagging

[20] Sánchez and Pachón (2013) find a positive cross-sectional effect of local taxation on access to drinking water using data from the population census of 2005.

[21] Sánchez and Vega (2014) report for Colombian departments a strong positive correlation between access to drinking water on infant mortality, so this latter indicator could also capture improvements in access to water and sanitation.

[22] The countries I consider are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Panama,

in primary educational enrolment and had intermediate results in health and water.

Table 2 shows that the net enrolment rate in basic education (five years of primary plus four years of secondary) is 88 % on average in the sample. According to the WDI from 2004 (column 2 in Table A1), Colombia ranked last in net primary enrolment (tied at 92 % with Bolivia and Venezuela). However, column 3 in Table A1 shows that net secondary enrolment was tied for third place at 63 %, outperforming Ecuador, Panama, Paraguay and Venezuela.

Regarding health, Table 2 shows that the average infant mortality rate in the sample is 22.8 per 1,000. Column 4 in Table A1 reveals that for this same indicator Colombia ranked sixth out of the twelve countries considered with 19 deaths per 1,000 infants in 2004. Going back to Table 2, 87 % of the poor population is covered by subsidized health insurance on average. Although there is no comparable data in the WDI, female life expectancy can provide us with a sense of where Colombia stands in terms of health within Latin America (without being biased due to the negative effects of internal armed conflict). Female life expectancy in Colombia is the seventh highest in the region (tied with Venezuela) at 76 years.

Finally, the average value of the IRCA water quality index in the sample is 29.38 (where less is better and below 5 is considered suitable for human consumption). Looking at the percentage of urban population with access to improved water sources in column 6 of Table A1, Colombia was sixth with 97 %. The country also ranked sixth (tied with Brazil and Mexico) in the percentage of urban population with improved sanitation facilities. However, data from the 2005 population census indicates that there is a substantial urban-rural disparity in water provision, with 91 % of the urban population having access to drinking water but only 46 % of the rural population having so, on average.

3.3. Identification Strategy

The objective of the empirical exercise is to estimate the causal effect of property tax revenue and oil royalties on the indicators of public good provision discussed above. I exploit the availability of panel data to estimate a series of models that include as controls both municipality and department-year fixed effects. I am thus able to control for persistent heterogeneity across municipalities as well as for common shocks affecting all municipalities simultaneously, allowing for these time effects to be potentially heterogeneous across departments.

Still, OLS estimates of the parameters of interest could be affected by reverse causality or omitted variable bias. For example, an increase in the demand for social services within

Paraguay, Peru, Uruguay and Venezuela.

a municipality over time may induce the local government to raise more taxes in order to be able to finance them. Similarly, the observed variation in oil royalties may reflect changes in other factors that can potentially affect the outcomes of interest, such as the discovery of new oil fields or an improvement in security conditions.

To address these concerns, I employ a source of plausibly exogenous variation for each source of revenue and I obtain instrumental variables (IV) estimates of the parameters of interest. More specifically, I exploit the timing of cadastral updates and the fluctuations in the world price of oil as sources of plausibly exogenous variation in property tax revenue and in oil royalties, respectively.

The following two sub-sections discuss the choice of instrumental variable for each source of revenue. The third sub-section presents the regression specifications for both the reduced form and the IV models.

3.3.1. Cadastral Updates and Property Tax Revenue

I use the timing of cadastral updates by IGAC as a source of exogenous variation in property tax revenue. Colombian law requires municipal cadastres to be updated every five years, but this condition is rarely satisfied. During the sample period, the average urban update takes place 11.4 years after the previous one, while the average rural update occurs 12.7 years after the last one. I address potential concerns about the endogenous timing of cadastral updates in several ways. I provide evidence against selection on observables and unobservables and I show that the timing of updates is driven for the most part by IGAC's supply, whose main criterion is the age of the current cadastre. I also provide suggestive evidence on an exogenous shock to the supply of updates, which led to a significant increase in the number of updates during the sample period. Furthermore, I provide evidence on municipalities' limited ability to manipulate property tax revenue following a cadastral update.

As a first validation exercise I check that the timing of a cadastral update is not correlated with changes in other observable municipal characteristics. I do this by estimating a series of bivariate regressions:

$$\left\{ \text{D(update)}_{i,j,t+1} = \alpha_i + \delta_{j,t} + \beta_k X^k_{i,t} + \epsilon_{i,j,t} \right\}_{k=1}^{K} \tag{1}$$

where $X^k_{i,t}$ is a time-varying characteristic indexed by k and $\text{D(update)}_{i,j,t+1}$ is a dummy equal to one the year before the update comes into effect. I define the dependent variable in this way to account for the fact that updates that take place in year t only come into effect on January 1st of year $t+1$. I include municipality (α_i) and department-year ($\delta_{j,t}$) fixed effects to ensure that I look at the variation that I will exploit in the main regressions.

I study thirty observable characteristics, which are listed in the left-most column of Table 3. I test for disproportionate increases in births, migration and urbanization around the time of an update using the natural log of population and the share of rural population. I look at other sources of revenue (other taxes, transfers, royalties) to check whether cadastral updates try to offset or to complement other changes in revenue. For instance, if municipalities were updating the cadastre to be able to exploit a good investment opportunity in social services, we would expect them to also try to raise more revenue from other sources. Similarly, if cadastral updates were caused by an unobserved improvement in public administration, we would also expect to observe increases in revenue from other local taxes.

I also check whether cadastral updates coincide with observable changes in local political characteristics using data from elections across all levels of government: municipal (mayor, council), departmental (governor) and national (president, congress). I construct indicators for political competition, such as the number of candidates for mayor, the number of parties running for council (per seat) and the vote shares of the winning mayor, departmental governor and president. I also construct Herfindahl–Hirschman concentration indices for mayor, council and congress elections. I study the party affiliation of the mayor, including whether it is different from that of the previous incumbent, whether it is the same as that of the departmental governor and the share of council members that belong to the mayor's party.

I consider the possibility that update years coincide with changes in the implementation of some national policies, such as the number of families enrolled in the conditional cash-transfer program *Familias en Acción* and the value of new loans made by the central government's agricultural bank, *Banco Agrario*. I also examine if cadastral updates are correlated with visits to the municipality by President Alvaro Uribe. During his eight years in office, President Uribe held a government meeting in a different municipality every week and these visits led to significant policy commitments (Tribín, 2014). Finally, I look at indicators on crime, illegal armed group presence and cultivation of narcotics to test for the possibility that conflict intensity or criminality improve around the time of an update.

Estimates of equation (1) for each of the variables mentioned above are presented in columns 1 and 2 of Table 3. Only one of the thirty variables considered, the number of parties participating in council elections, has a statistically significant correlation with the timing of cadastral updating.[23] Although this correlation can be explained as a result of sampling error,

[23] Sánchez and Pachón (2013) and Sánchez and España (2013) report results from similar regressions using a logit model. Although these authors find significant correlations with transfers, income and some political characteristics, the difference is probably driven by the lack of municipality fixed effects in those estimations.

I verify that the results below are robust to including this or any other variable as a control (available upon request). Columns 3 and 4 show results from an expanded specification that includes dummy variables for the first five years after urban and rural updates as controls. The results are essentially unchanged, which indicates that the point estimates are not attenuated by the very low probability of a new update in the years right after the last one.

Although I am unable to definitely rule out that variation in unobservables is affecting the decision to update, it is not easy to think of changes in unobserved characteristics that would not be picked up by the observable characteristics studied in Table 3. Additionally, I show below that the main results are robust to the substitution of municipality fixed effects for the more stringent municipality-term fixed effects, which capture any unobserved within-municipality heterogeneity across local political terms.

One potential driver of cadastral updating is growth in the housing market. As property values increase, municipal governments may find it more attractive to update the cadastre in order to capture some of these higher values in the form of property tax revenue. I test for this possibility by comparing the implied yearly growth rates of property values of updates that occur close to the previous one, which are unusual and more suspicious of selection, to those that occur later.

I first illustrate the time path of cadastral updates by regressing an update year dummy on a full set of indicators for the number of years since the previous update, leaving the year immediately after an update as the omitted category. The results from this regression (which includes municipality and department-year fixed effects) are shown in panel (a) of Figure 2. The probability of a new cadastral update is very low in the five years following the last one, it then jumps by more than thirty percentage points between the fifth and seventh year and it rises smoothly from the eight year onwards.

I use the total property values revealed by the cadastral updates for each municipality to construct the implied yearly growth rate in property values.[24] I then use the cross-sectional sample of cadastral updates and regress the growth rate on the dummies for the different number of years since the previous update, leaving the fifth year after an update as the omitted category for ease of interpretation. The results from this regression are shown in panel (b) of Figure 2. The estimates indicate that with the exception of updates occurring one or two years after the last one, which are truly exceptional, the growth rate in property values is not heterogeneous by the number of years since the last update, despite the large underlying differences in the probability of updating. In other words, a cadastral update that takes place four years after the last one, which is very unusual and hence suspicious of

[24] For municipalities for which I do not observe at least two updates after 2000, which is the first year for which I have data on property values, I use the property values from 2000 as baseline.

selection bias, reveals the same yearly growth rate in property values as a much more likely update that takes place ten years after the last update.

The previous exercises suggest that municipalities have a limited ability to manipulate the timing of cadastral updates. I now provide additional evidence that indicates that cadastral updating is mainly determined by the supply of updates from IGAC. The first piece of evidence comes from the pre-selection of municipalities for cadastral updating that is done by IGAC at the start of every year. This information is not publicly available but I had access to the lists of municipalities prioritized by IGAC in 2011 and 2012. Matching these lists with the actual updates that took place each year, I find that 80 % of updaters were in IGAC's initial list and that 68 % of those pre-selected actually updated. These numbers indicate that although there is room for selection into and out of updating at the margin, the bulk of updates are determined by IGAC. Furthermore, when I estimate equation (1) with a dummy for inclusion in the list as dependent variable, I find that the only robust predictors of inclusion are the number of years since the last urban and rural updates (results available upon request). This is consistent with IGAC's objective of keeping the cadastres as up-to-date as possible.

The second piece of evidence on IGAC's authority over the timing of cadastral updates is based on the effect that the incentives provided to IGAC by the central government during the sample period had on the number of updates and their type. Alvaro Uribe included as part of his official government goals for his first term as President (2002-2006) to have the urban cadastres of all municipalities up to date (updated in the last five years). For his second administration (2006-2010), Uribe set as goals for IGAC to have 90 % of urban cadastres and 70 % of rural cadastres up to date. As Figure A1 shows, these targets were binding constraints for IGAC throughout the sample period. Additionally to these incentives, the central government used an IDB loan to provide funding for the cadastral updates of the urban areas of 145 municipalities in 2007.

Figure 3 shows the number of updates per year and their type. The graph indicates the president in office each year, bearing in mind once again that there is a one-year lag in the validity of updated cadastres. The graph shows that the number of updates, particularly urban ones, increased dramatically between 2004 and 2007, which coincides with the introduction of incentives for this type of update by the first Uribe administration. After 2007, the number of updates per year remains relatively high, but we observe a shift towards rural updates, which coincides with the introduction of incentives for this type of update by the second Uribe administration.

As a result of the increased supply of updates, 60 % of the municipalities in the sample had a cadastral update between the years 2006 and 2010. These are the update cohorts that

I employ for the estimations below. The map in Figure 8b shows that the municipalities belonging to these update cohorts are evenly distributed throughout the country.

I further use the yearly variation in the supply of updates to look for evidence on selection into cadastral updating. I consider the possibility that municipalities are intentionally updating to collect more tax revenue and I try to get a sense of the size of this selection effect by comparing the effect of updating on tax revenue across update cohorts. This exercise is motivated by the large variation in number and type of updates shown in Figure 3, which potentially reflects large differences in the composition of the update pool. For this purpose, I regress property tax revenue on a set of separate post-update dummies for each cohort between 2002 and 2011 (including municipality and department-year fixed effects). The results, shown in Figure 4, indicate that cadastral updating leads to a 25 % increase in property tax revenue, with the return being very homogeneous across cohorts. More specifically, I am unable to reject the null hypothesis that the return in tax revenue is the same for all cohorts between 2002 and 2011, despite the large differences in the number and type of updates across cohorts illustrated in Figure 3. Taken together, the available evidence indicates that municipalities have a limited ability to manipulate the timing of the cadastral updates and that this timing is mainly driven by the supply from IGAC. However, municipalities have discretion over how much taxes to collect. Autonomy over tax collection could be a problem if, for instance, only the municipalities with good investment opportunities collect more taxes after a cadastral update. Figure 4 already suggests that municipal governments do not enjoy large discretion over tax collection conditional on updating the cadastre. I provide additional evidence on the limited ability of municipalities to manipulate statutory tax rates using data from Iregui et al. (2003) for 211 municipalities between 1999 and 2002. I regress the statutory property tax rate on a dummy for the years after a cadastral update, including municipality and year fixed effects. The estimates in Table A2 are very small and statistically insignificant, indicating that municipalities do not adjust statutory rates in response to cadastral updates.[25] Finally, in Figure 5 I plot the average change in property tax revenue after a cadastral update for the 2006-2010 update cohorts (relative to the year before the update). The graph shows that the number of "compliers" is fairly large, as roughly 75 % of updates lead to an increase in property tax revenue.

3.3.2. Oil Price Shocks and Natural Resource Royalties

The second part of the identification strategy exploits plausibly exogenous variation in the world price of oil, the heterogeneous distribution of this resource across Colombian

[25] Sánchez and España (2013) provide additional evidence from interviews with public officials from several Colombian municipalities on the stickiness of statutory property tax rates.

municipalities and the royalty allocation formula discussed in the background section.[26] In this case, identification is based on two assumptions. The first one is that the world price of oil is exogenous to local conditions in Colombian municipalities. This is a plausible assumption because Colombia is a relatively small exporter of oil. According to the US Energy Information Administration, Colombia is the 18th largest exporter of oil with less than 1 % of world exports.

As a measure of oil abundance I use the average amount of oil royalties received by the municipality between 2000 and 2004 ($\text{royalties}^{\text{oil}}_{i,00-04}$). I use this five-year average to address potential concerns related to regression to the mean in oil royalties. The second assumption necessary for identification is that any systematic differences between municipalities with different levels of oil abundance are time-invariant and thus captured by the municipality fixed effects.

By interacting the average 2000-2004 oil royalties with the world oil price index for a given year I obtain an indicator of predicted royalties if oil output stays at the average pre-sample period level and the only variation is that coming from world price fluctuations. The variation resulting from oil discoveries, for example, is not exploited by this research design. What I exploit is the differential impact of variation in the price of oil in municipalities with varying levels of average oil extraction in the previous years.

Figure 7a provides an illustration of the identification strategy for royalties. The black line in the graph corresponds to the world oil price index (right axis). The price of oil increased up to 2008, crashed in 2009 as a result of the global financial crisis and recovered in the last two years of the sample period. The figure also shows point estimates and 95 % confidence intervals (left axis) from the following regression:

$$\text{royalties}_{i,j,t} = \alpha_i + \delta_{j,t} + \sum_{k=2006}^{2011} \beta_k \left[D(\text{year} = k)_t \times D(\text{oil royalties} > 0)_{i,00-04} \right] + \epsilon_{i,j,t} \qquad (2)$$

where the dependent variable is royalties per capita in municipality i from department j in year t. α_i and $\delta_{j,t}$ are municipality and department-year fixed effects, respectively. The coefficients of interest β_k capture the average yearly royalties among the set of oil-rich municipalities (positive oil royalties between 2000 and 2004) relative to 2005, which is the omitted year. The graph shows that royalties in these oil-producing municipalities track the yearly variation in the price of oil: higher oil prices lead to more royalties. The results also illustrate the large amount of revenue provided by oil royalties to these municipalities. For example, when the price of oil was at its peak in 2008, the average oil-rich municipality received

[26] This type of difference-in-differences methodology has been widely used in recent studies on Colombia. See, for example, Dube and Vargas (2013); Carreri and Dube (2015); Santos (2014); Idrobo et al. (2014).

100,000 COP per capita of royalties above of what it had received in 2005. This corresponds to 20 % of the total yearly revenue per capita of the average municipality in the sample, according to Table 2.

The map in Figure 8a shows sextiles of the distribution of (positive) average oil royalties between 2000 and 2004. Even though oil royalties are geographically clustered in areas where there is oil, there is still substantial within-region variation in oil intensity. The inclusion of department-year fixed effects in all regressions ensures that I only exploit within-department variation in oil intensity. A comparison with the map in Figure 8b additionally shows that there is substantial overlap between oil-royalty recipients and municipalities with a cadastral update. This allows me to verify that any differential effects across sources of revenue are not driven by systematic differences in the use of revenue across municipalities irrespective of the source.

3.3.3. Reduced Form and Instrumental Variables Specifications

In what follows I use two main specifications. I show reduced-form effects of cadastral updating and predicted oil royalties using the following model:

$$\mathrm{y}_{i,j,t} = \alpha_i + \delta_{j,t} + \gamma_T \mathrm{D(post\text{-}update)}_{i,t} + \gamma_R \left[\mathrm{price}_t^{\mathrm{oil}} \times \mathrm{royalties}_{i,00-04}^{\mathrm{oil}}\right] + \epsilon_{i,j,t} \tag{3}$$

where $\mathrm{y}_{i,j,t}$ is an outcome of interest and α_i and $\delta_{j,t}$ are municipality and department-year fixed effects, respectively. The standard errors are clustered two-way by municipality and department-year following Cameron et al. (2011).

I estimate the effects of tax revenue and royalties on the outcomes of interest using an instrumental variables model:

$$\mathrm{y}_{i,j,t} = \alpha_i + \delta_{j,t} + \beta_T \mathrm{property}\ \widehat{\mathrm{tax}}\ \mathrm{revenue}_{i,t} + \beta_R \mathrm{natural}\ \widehat{\mathrm{resource}}\ \mathrm{royalties}_{i,t} + u_{i,j,t} \tag{4}$$

where the cadastral update dummy and the predicted oil royalties are used as instruments for tax revenue and natural resource royalties, respectively.

To account for the fact that there may be a lag in the expenditure of royalties, I also show estimates of modified versions of equations 3 and 4 that include cumulative royalties ($\sum_{k=2006}^{t} \mathrm{royalties}_{i,k}$) instead of its contemporary value. This is a more flexible specification as it allows for the effect of royalties to manifest at a later date than when they are collected. Since the municipality fixed effect absorbs all royalties up to 2005, the cumulative is actually a partial one since 2005. As an instrument for cumulative royalties I use the cumulative of predicted royalties: $\sum_{k=2006}^{t} \mathrm{royalties}_{i,00-04}^{\mathrm{oil}} \times \mathrm{price}_k^{\mathrm{oil}}$.

Table 4 shows the results from the first-stage regressions. Column 1 shows that cadastral updating leads on average to an increase of 6,000 COP per capita in property tax revenue. Column 2 shows that a one COP per capita increase in predicted oil royalties leads to a 0.85 COP per capita increase in royalties. The results for cumulative royalties, shown in column 3, are very similar. One extra peso of predicted cumulative royalties leads to 0.8 extra pesos of actual cumulative royalties. The three estimates are statistically different from zero at the 1 % level.

4. Results on Public Good Provision

4.1. Main Results

Table 5 shows the main results of the paper. Panel A shows reduced-form estimates of the effect of the instruments on the outcomes of interest. The dependent variable is specified in the header of each column. Columns 1-4 look at the continuous variables (in logs), while columns 5-8 look at dummy variables for the achievement of the targets from Table 1. Panel B shows the corresponding IV estimates.

The results in columns 1-4 of panel A indicate that a cadastral update leads to a 0.8 % increase in educational enrolment and to a 12 % increase in the water quality index. Both of these effects are statistically significant at the 5 % level. The effect on the percentage of poor population with subsidized health insurance is also positive (1.2 % increase), but not statistically significant. In the case of infant mortality, the point estimate for tax revenue is positive, but the effect is very small and it is statistically insignificant. The results in the second row of panel A show that a 10,000 COP per capita increase in predicted royalties leads to a 1 percent increase in the water quality index. This effect is significant at the 10 % level. The estimates for the other indicators are all very small and statistically insignificant.

According to the IV estimates in columns 1-4 of panel B, which scale the reduced-form estimates by the corresponding change in revenue, a $10,000 COP per capita increase in property tax revenue leads to a 1.4 % increase in educational enrolment and to a 14 % increase in the water quality index. These effects are larger than those of an equivalent increase in royalties by more than one order of magnitude and the difference is statistically significant at the 5 % and 10 % levels, respectively. The results for subsidized health insurance point in the same direction but the difference is not statistically significant. Overall, there is no evidence that natural resource royalties have a positive effect on any of the outcomes.

The results on target achievement in columns 5-8 of Table 5 paint a similar picture. The reduced-form estimates in panel A indicate that a cadastral update increases the probability of having universal coverage of poor population with subsidized health insurance by 3 percentage points. This is a relatively large effect, given that only 15 % of municipalities met this target in 2005, and it is also statistically significant at the 10 % level. Column 4 additionally shows that a cadastral update leads to an increase of 7.6 percentage points in the probability that water in the municipality is suitable for human consumption. The IV results in panel B indicate that these positive effects of tax revenue on target achievement in the areas of health and water are significantly different from those of natural resource royalties at the 10 % and 1 % levels, respectively. None of the point estimates for royalties in panel B are statistically different from zero and they are all very small.

These results indicate that locally-raised property tax revenue has a positive effect on public service provision in the areas of education, health and water. I find a positive effect of property tax revenue on educational enrolment but not on the probability of full enrolment, which indicates that the increases in enrolment are taking place in municipalities farther away from the target. Property tax revenue has a positive effect on the percentage of poor population with subsidized health insurance and on the probability of universal coverage, but the estimate is only statistically significant for the latter. This suggests that the increases in coverage are coming from municipalities that are close to meeting the target. The lack of an effect on infant mortality should not surprise us, as this is a complex indicator that only partially depends on the supply of health services by public authorities. For instance, only 1 % of deaths during the first five months of life in 2001 were due to diseases preventable through vaccination (MPS, 2005).

The reported effects of property tax revenue on public goods are at least ten times larger than and statistically different from those of an equivalent increase in royalties from the extraction of natural resources. These differences are particularly striking as natural resource royalties are earmarked for expenditure on the specific set of public goods that I study. Despite the resulting bias in favour of royalties, I find no robust evidence of an effect on the indicators of public service provision.

4.2. Robustness Checks and Alternative Explanations

In this section I explore several alternative explanations for the previous findings. The first one is that the effect of revenue on public goods is different in municipalities that update the cadastre and in those that receive natural resource royalties, irrespective of the source. To address this possibility, in Table 6 I explore whether the reduced-form effect of cadastral updating is heterogeneous by average 2000-2004 oil royalties. I find no evidence of such a heterogeneity. In all specifications the point estimates for the interaction between cadastral updating and oil intensity are very small and never statistically different from zero. Furthermore, I can reject the null hypothesis that cadastral updating has no effect on educational enrolment, water quality and subsidized health insurance for the poor at the median and mean levels of positive oil royalties.

I explore the possibility that the results on cadastral updates are driven by unobservable changes in local government by checking whether the results are robust to the inclusion of municipality-term fixed effects. The results in Table A4 show that even with this more stringent specification there is still a statistically significant difference between the two sources of revenue for educational enrolment and for the probability of having water suitable for human consumption.

I also consider the possibility that the extremely low return of natural resource royalties is specific to royalties from the extraction of oil. I use data on the royalties from the extraction of coal in 2004 and on the world price of this resource to construct an indicator of predicted coal royalties. Table A7 shows estimates of equations (3) and (4) for coal royalties. The results are qualitatively and quantitatively similar to the ones for oil.

Another alternative explanation is that the effect of natural resource royalties takes more time to materialize than the effect of tax revenue. One reason why this might happen is if royalties are not spent in the same year in which they are received. Another reason is if royalties are spent on large-scale projects that require more time to be completed. This latter explanation seems feasible given the large amount of revenue that royalties represent.

Cumulative royalties allow for a lag in the effect of revenue from this source and thus provide a solution to the problem. Table A3 replicates the analysis from Table 5 using cumulative royalties instead of their contemporary value. The results on tax revenue are unchanged while the results on royalties deteriorate significantly. The IV estimates in panel B indicate that cumulative royalties lead to a worsening of all the outcomes considered, except infant mortality, and the point estimates are statistically significant in the cases of subsidized health insurance and water quality.

I provide additional evidence against the higher return of royalties in the medium run based on regressions similar to equation (2), but using the outcomes of interest as dependent variables. The results are shown in panels (c)-(f) of Figure 7. As already discussed, panel (a) shows that these oil-endowed municipalities never receive less royalties than in 2005, and actually receive more between 2006 and 2008. Panel (b) shows that they never spend less than in 2005, but they do spend significantly more in 2006 and 2007. However, the results in panels (c)-(f) are consistent with the previous findings: despite the extra revenue and the extra expenditure there is no observable improvement for any indicator. If anything, they seem to worsen.

I turn next to the possibility that changes in the price of oil may affect the outcomes of interest in the municipalities where oil is extracted through other channels besides royalties. As mentioned above, the research design only uses variation in royalties from municipalities where oil was already being extracted in the period 2000-2004, so the results cannot be explained by the structural transformation associated with oil discoveries (Michaels, 2011). Nevertheless, panel A of Table 7 shows that contemporary oil-price shocks are positively correlated with activity by the guerrilla group FARC and they are negatively correlated with the homicide rate. These two correlations suggest that FARC may be exercising control over other criminal activities. The results in panel B show that cumulative royalties, on the other hand, are positively correlated with population and with business tax revenue, which has been used before as a proxy for municipal GDP (Sánchez and Núñez, 2000). These results are consistent with the idea that a series of positive oil-price shocks lead to an economic boom in the municipality and that better economic conditions generate immigration.[27]

The results in Table 7 suggest that increased population and armed group presence at the time of higher oil prices may be biasing the estimates for royalties from the previous section. I provide a first piece of evidence against this alternative explanation by showing that the results are unaffected by the inclusion of the variables from Table 7 as controls. Figure 9 shows point estimates and 95 % confidence intervals for royalties from equation 3, next to the ones from an enlarged specification that includes controls for population (natural log), business tax revenue, murder rate and FARC activity. The figure shows that the estimates are remarkably robust to the inclusion of these control variables. Although they are 'bad controls' in the sense of Angrist and Pischke (2009), the robustness of the estimates indicates that these variables are not driving the estimated effects.

I further explore the violations of the exclusion restriction for royalties by looking at the cross-sectional variation in oil intensity, measured again as average oil royalties between 2000 and 2004. Figure 6 shows yearly average total revenue (panel A) and royalties (panel B) for each quartile of the distribution of average positive 2000-2004 royalties, as well as for municipalities that did not receive oil royalties in this period. The takeaway from these graphs is that municipalities in the top quartile are much richer than all other municipalities and that this extra revenue is clearly coming from natural resource royalties. Municipalities in the third quartile, on the other hand, appear to be much more comparable to the rest of the country.

In Table A5 I look at the effect of oil price shocks separately for municipalities in the third and fourth quartiles. Column 1 of the different panels shows a positive effect of predicted

[27] Several previous studies have exploited commodity-price shocks as a source of variation in local income (Miller and Urdinola, 2010; Dube and Vargas, 2013; Acemoglu et al., 2013; Asher and Novosad, 2014).

royalties on actual royalties (contemporary and cumulative) for both quartiles. This is confirmed by panel (a) in Figure A2, which shows results from separate estimations of equation (3) for each of the top two quartiles. However, columns 2-5 provide evidence of heterogeneous non-fiscal effects across these quartiles. The correlation with business tax revenue and FARC activity is only present for the top quartile and the effect on population is much stronger for this group of municipalities. Overall, the non-fiscal effects of oil-price shocks appear to be much weaker in municipalities belonging to the third quartile. However, the results in columns 6-9 provide no robust evidence of a reduced-form effect on the outcomes of interest in either quartile. The yearly averages for each outcome shown in panels (c)-(f) of Figure A2 point in the same direction: municipalities in the third quartile of the oil intensity distribution receive more royalties when the price of oil is high but show no improvement in public service provision despite the weaker non-fiscal effects.

I next exploit the geographic concentration of FARC activity to better understand the extent to which illegal armed group presence may be driving the very low impact of natural resource royalties on the outcomes of interest. I calculate for each municipality the average number of FARC events per capita between 2005 and 2010, the last year for which data is available, and I estimate an expanded version of equation (3) that includes the interaction between the predicted royalties measure and this time-invariant indicator of FARC activity.[28] The results are shown in Table A6 of the appendix. Column 1 shows that additional predicted royalties lead to more actual royalties, irrespective of FARC presence. Columns 2-5 look at the main outcomes of interest. The results provide two main lessons. First, there is evidence that FARC presence attenuates the impact of additional predicted royalties on educational enrolment and water quality in columns 2 and 5. Secondly, the estimates in the second row of each panel indicate that even in those municipalities that receive oil royalties but that did not have any FARC presence during the sample period (roughly 1/3) the effect of additional predicted royalties remains very close to zero and is always at least one order of magnitude smaller than that of a cadastral update.

The final alternative explanation that I consider is that the results are driven by differences in the variability of revenue across the two sources. After all, cadastral updates lead to a stable increase in tax revenue while oil price shocks lead to unpredictable and potentially large variation in oil royalties. The higher variance of royalties may induce local governments to be more prudent in the way they spend these occasional resource windfalls. If this is the case, we should observe that the propensity to spend the marginal peso of royalties is smaller than the propensity to spend the marginal peso of taxes.

[28]As before, this is most likely a 'bad control', so my main interest is the robustness of the estimates of the parameters of interest to its inclusion.

Panel A in Table 8 shows results from estimating equation 4 using total expenditure per capita as dependent variable. I introduce a one-year lag in royalties to account for the delay in expenditure. Separate regressions for each source of revenue in columns 1 and 2 reveal that one extra COP of tax revenue leads to approximately 1.3 extra COP of expenditure, while one extra COP of royalties leads to 0.6 extra COP of expenditure. Although the point estimate for tax revenue is more than twice as large as that for royalties, the standard errors are quite large and I fail to reject the null hypothesis that the coefficients are equal to 1. The results are similar if I look at both sources in the same regression: even though the point estimate for tax revenue increases to 1.8, which is three times the propensity to spend royalties, I still fail to reject the null that the coefficients are both equal to 1. Even with this larger difference, it would take some very high returns to scale in expenditure for total spending patterns to explain the results on public goods. Furthermore, column 4 shows that by using cumulative royalties instead, which impose less structure on the timing of expenditure than the lag, the coefficient for royalties rises to 1.2. This coefficient is much closer to the estimates for tax revenue and is, once again, not statistically different from 1.

Panels B and C replicate the previous analysis for the two main sub-categories of expenditure, operating expenses and investment (gross fixed capital formation, more specifically). The estimates for investment in panel B are very similar to the ones for total expenditure and I cannot reject the null hypothesis that the propensity to invest out of both sources is the same and is equal to 1. The point estimates for operating costs in panel C are much smaller and still statistically equivalent across sources. Taken together, these results indicate that tax revenue and royalties are almost exclusively spent on infrastructure investment. They also suggest that revenue from neither source is being systematically employed for patronage and job creation, as this would be reflected in higher wages and higher operating costs.

The similar spending patterns of tax revenue and natural resource royalties, together with the heterogeneous effects of revenue from these two sources on public service provision, suggest that the unobservable quality of spending might be higher for projects financed with tax revenue than for those funded through natural resource royalties. I use data on two indicators of educational infrastructure provided by the Ministry of Education, the number of schools and the teaching area (sq. metres), to provide evidence on the heterogeneous returns to investment across sources of revenue.

Table 9 shows estimates of equations (3) and (4) using these two indicators (and their normalized version by population) as dependent variables. The results in column 1 show that a 10,000 COP increase in property tax revenue leads to 1.4 more schools in the municipality, while an equivalent increase in natural resource royalties leads to a negligible 0.007 increase. The difference between the two IV coefficients is statistically significant at the 10 % level.

Similarly, the estimates in column 3 indicate that the effect of tax revenue on teaching area is much larger than that of natural resource royalties, although the difference is not statistically significant. There is also no statistically significant difference for the population-adjusted indicators in columns 2 and 4, which suggests that the improvements in educational infrastructure brought about by additional tax revenue are not proportional to population.

5. Evidence from Disciplinary Prosecutions

In this section I provide evidence on the heterogeneous effect of increases in tax revenue and natural resource royalties on the disciplinary prosecution of local public officials. All else equal, more prosecutions imply more misbehavior, so I take this as proxy evidence on the heterogeneous responses of local public officials to increases in revenue from the two sources.

The watchdog agency *Procuraduría General de la Nación* (PGN) oversees public employees' compliance with a general disciplinary code. This includes local public officials, such as the mayor, top members of staff (e.g. secretary of education) and municipal council members. PGN may start an investigation based on news reports, tip-offs, audit results and reports from other government agencies such as the fiscal watchdog *Contraloría General de la República* (CGR). PGN can hand out sanctions ranging from fines and short suspensions for small offences to the removal from office and a ban from future public employment and public office. These latter sanctions are reserved for serious offences, including gross mismanagement of public funds, corruption and violations of procurement and contracting laws.

I collected a new dataset on disciplinary prosecutions by PGN using publicly available news reports from the agency's website for the years 2004-2015.[29] For each case, I recorded the names of the accused, their roles in the public administration, the nature of the charges, the timing of the events, the stage of the process and the outcome. Based on these characteristics I was able to link multiple reports related to the same case. I have data on 1381 cases taking place in 516 municipalities.

I construct a series of indicators at the municipality-term level based on the disaggregate prosecution data and I estimate modified versions of equations (3) and (4). I use these broader time periods because it is not always possible to pin down the specific year in which the alleged misconduct took place. To increase the sample size, I use data from the local political periods 2001-2003, 2004-2007 and 2008-2011. I use oil royalties in 2000 from *Ecopetrol* as the cross-sectional indicator of oil intensity to construct the predicted royalties and I also substitute the post-update dummy for the cumulative number of cadastral updates.

[29] http://www.procuraduria.gov.co

The reduced-form estimates in panel A of Table 10 and the corresponding IV estimates in panel B indicate that higher natural resource royalties lead to an increase in the probability that the mayor and top members of staff are prosecuted, found guilty and removed from office. According to columns 1-3 in panel B, a 10,000 COP increase in royalties increases the probability that the local mayor is prosecuted (1 pp. increase), found guilty (0.8 pp. increase) and removed from office (0.5 pp. increase). These are not negligible effects given that 19 % of mayors are prosecuted, 14 % are found guilty and 8 % are removed from office. They are also statistically significant at conventional levels. The results for top members of staff in columns 4-6 are qualitatively similar. Additional tax revenue, on the other hand, appears to have a negative effect on the likelihood of these events, although the estimates are very imprecisely estimated and I fail to reject the hypothesis that the effect of tax revenue is the same as that of natural resource royalties.

The findings in columns 3 and 6 are very telling, as they indicate that the offenses for which local public officials are prosecuted during periods of high royalties are serious ones, such as corruption and embezzlement. Table A8 summarizes some of the processes that resulted in the removal from office of the mayor of an oil-rich municipality. Most of these cases are clear instances of mismanagement of public funds, such as the provision of spa treatments for city hall workers by the mayor of Yopal. Many of the cases are related to the management and expenditure of natural resource royalties, such as the loss of 5 million USD worth of royalties in Arauca after they were given to an informal firm to manage and it went bankrupt. Table A9 looks at the most frequent keywords for the processes involving mayors of oil-rich municipalities. 36 % of cases are related to irregularities in investment and procurement and 12 % of processes are related to natural resource royalties. These are the modal keywords for the type of misconduct and the sector among this group of municipalities.

6. Discussion

I have provided evidence on the larger effect of tax revenue on public goods relative to natural resource royalties and I have shown that additional royalties lead to a worsening of the misbehavior of local politicians. In this section, I discuss these findings and I establish a relationship between them. I argue that accountability underlies the relationship between taxation and governance and I provide some suggestive evidence.

One straightforward reason why taxation may be positively related to accountability is because voters are better informed about changes in taxation than about changes in external revenue. This informational asymmetry across sources of revenue arises because taxation is in itself informative about government revenue, while information on revenue from other sources must be acquired at a cost. In consequence, if voters do not know that the government has more resources they have no reason to expect or demand an improvement in public services.

In the theoretical appendix I explore this mechanism in the context of a political agency model with career concerns.[30] In the model, voters receive a noisy signal on public revenue, the precision of which is improved by the share of taxes in total revenue. As the revenue signal becomes more precise, voters are more able to infer the incumbent's ability after observing public good provision. Hence, taxation makes the voters' posterior beliefs on the incumbent's ability more sensitive to observed public goods and this leads to higher effort by the incumbent and to more public goods. As external revenue increases, on the other hand, voters become less well informed about revenue and this has a negative effect on the incumbent's effort. Thus, external revenue has a smaller effect on public goods than tax revenue.

This informational explanation is consistent with various findings from the empirical literature. Recent studies provide evidence in support of the idea that voters find it difficult to establish the contribution of government to observed outcomes (Leigh, 2009; De la O, 2013; Guiteras and Mobarak, 2014). Recent research also indicates that voters are relatively uninformed about changes in external revenue (Reinikka and Svensson, 2004; Ferraz and Monteiro, 2014; Gadenne, 2015). Additionally, there is a large literature showing that governments are generally more accountable to voters that are better informed.[31]

One may still wonder how can residents of resource-rich areas not be aware of the flow of resource rents to their government. The point here is that even if voters in these areas know about the abundance of natural resource rents, they must still pay close attention to fluctuations in prices and output to be well informed about the change in these rents. This is important because the empirical exercise above was concerned with changes in revenue from different sources, rather than with their average level, which was absorbed by the municipality fixed effects.

One could also wonder how informative it is to pay your own taxes in a world with significant heterogeneity in tax liabilities. Although this does raise the question about which are the taxes that matter, it is not a major concern for the empirical exercise on Colombia as the cadastral updates that I study lead to a municipality-wide simultaneous increase in tax liabilities. A related question is whether increases to taxation simply make voters,

[30] The model is an extension of the canonical career concerns model of Persson and Tabellini (2000) that incorporates 'signal-jamming' à la Holmström (1999). Alesina and Tabellini (2007) and Matsen et al. (2015) use similar extensions to answer very different questions.

[31] See Besley and Burgess (2002); Reinikka and Svensson (2005); Ferraz and Finan (2008); Björkman and Svensson (2009); Snyder and Strömberg (2010); Banerjee et al. (2011); Fergusson et al. (2013); Chong et al. (2015).

who are already well informed about revenue, more aware of the public purse and its use (increased salience). An explanation along these lines seems particularly plausible for the current setting because the property tax stands out in this respect, as it is a yearly out-of-pocket tax payment on an illiquid asset (Cabral and Hoxby, 2015). Additionally, there is evidence that people's response to taxation is affected by the salience of taxes (Chetty et al., 2009; Finkelstein, 2009).

The other main channel through which the relationship between taxation and accountability may arise is citizens' preferences. It is possible, for instance, that voters simply dislike taxation and punish the incumbent for it unless he compensates them with improved public services. Martin (2014) develops a model along these lines in which loss-averse voters derive utility from punishing a corrupt government.[32]

In the appendix, I present an alternative version of the theoretical model described above in which the marginal utility of public goods is decreasing in private consumption and voters can acquire costly information on public revenue. I show that taxation may improve incumbent effort and public good provision, even if it is not by itself directly informative, because it induces the acquisition of costly information on government revenue due to its negative effect on disposable income.

There is some empirical evidence supporting these preference-based channels. Both Paler (2013) and Martin (2014) find that participants in lab experiments are more willing to engage in costly punishment of a misbehaving government when the source of revenue is taxation than when it is external, even when information is held constant across treatments. There is also a large literature on reciprocity that has found that people are willing to incur in costly punishment of what they consider to be unfair behavior (Fehr and Gächter, 2000).

Overall, taxation may either increase citizens' willingness to hold the government accountable or their ability to do so (Paler, 2013). Although the available data does not allow me to distinguish between these explanations, all of them predict that tax revenue leads to higher accountability and to better governance. I use data on social mobilizations from the Colombian think-tank CINEP to provide suggestive evidence on the heterogeneous effects of tax revenue and natural resource royalties on accountability and the demand for better government.

Table 11 shows reduced-form and IV estimates of the effects of property tax revenue and natural resource royalties on various indicators of citizen involvement in public affairs. The results indicate that property tax revenue appears to have a positive effect on the probability of social mobilizations of any kind (column 1), but more specifically on the probability of

[32] In the model in the appendix, forward-looking voters cannot credibly commit to vote against the incumbent if they believe him to be of higher ability than his opponent in the election.

demonstrations (column 2), especially those related to public services (column 3). These are not negligible effects. For example, I find that a 10,000 COP increase in property tax revenue leads to a 1 percentage point increase in the probability of demonstrations related to public services, relative to a sample mean of 2.8 %. The effect of tax revenue on worker strikes (column 4) is negative and much smaller, which acts as a placebo test. The effects of natural resource royalties are negative but very small for all indicators. Unfortunately, the standard errors are large for all estimates and the difference across sources of revenue is not statistically significant for any indicator.

7. Conclusion

In this paper I estimate the effect of locally-raised property tax revenue on several indicators of public service provision in Colombian municipalities and I use these estimates as a benchmark to compare the effect of revenue from an external source, the rents from the extraction of oil. I show that property tax revenue has a positive impact on public services in the areas of education, health and water, while oil royalties have no effect on local public services, despite being earmarked for this purpose. I provide suggestive evidence on the positive relationship between taxation and the demand for good government, as measured by social mobilizations and protests, and on the negative relationship between external revenue and the supply of good government, as measured by disciplinary prosecutions.

These results confirm previous findings regarding the very low impact of revenue from external or unearned sources - such as natural resource rents, intra-government transfers and foreign aid - on public good provision. But they go further than that, as they allow us to see that this very small effect is indeed specific to external revenue and that tax revenue has a very different and much larger impact. Additionally, this paper illustrates how the heterogeneous response of local politicians to increases in revenue from the two sources, as well as that of the citizens to whom they are accountable, is what drives the heterogeneity in returns. Hence, the case for the 'political' nature of the curse of 'external' resources is strengthened.

The findings of this paper, insofar as they provide evidence on the positive relationship between taxation, accountability and governance, have important implications for policies related to the design of decentralized systems of government, the management of natural resource wealth and the disbursement of foreign aid. Mainly, they invite policymakers to reconsider the effectiveness of resources that are transferred to governments, both across countries and within countries, for projects or services that lack a locally-financed counterpart. More specifically, the evidence in this paper suggests that citizen involvement is crucial for the responsible management of public funds and that taxation is an effective way of achieving such involvement.

At present developing countries tax too little, both at the national and sub-national levels (Gadenne and Singhal, 2014). The results in this paper also suggest that there may be high returns to investments in fiscal capacity in terms of improved public service provision and higher living standards.

Future research must try to better understand the relative importance of information and preferences as the driving forces behind taxation's ability to improve government performance. Another avenue for future research is related to the study of different tax instruments with the objective of establishing whether certain characteristics, such as salience, are particularly important for the accountability-enhancing effect of taxation.

References

Acemoglu, Daron, Amy Finkelstein, and Matthew J. Notowidigdo (2013), "Income and health spending: Evidence from oil price shocks." *The Review of Economics and Statistics*, 95 (4), 1079–1095.

Alesina, Alberto, Alberto Carrasquilla, and Juan Jose Echevarria (2005), "Decentralization in Colombia." In *Institutional reforms in Colombia* (Alberto Alesina, ed.), MIT Press, Cambridge, MA.

Alesina, Alberto and Guido Tabellini (2007), "Bureaucrats or politicians? part I: A single policy task." *American Economic Review*, 97 (1), 169–179.

Angrist, Joshua D. and Jörn-Steffen Pischke (2009), *Mostly Harmless Econometrics: an empiricist's companion*. Princeton University Press, Princeton, NJ.

Asher, Samuel and Paul Novosad (2014), "Digging for development: Mining booms and local economic development in India." Working Paper.

Banerjee, Abhijit, Selvan Kumar, Rohini Pande, and Felix Su (2011), "Do informed voters make better choices? experimental evidence from urban India." Working Paper.

Bardhan, Pranab (2002), "Decentralization of governance and development." *Journal of Economic Perspectives*, 16 (4), 185–205.

Bardhan, Pranab and Dilip Mookherjee (2006), "Decentralization, corruption and government accountability: An overview." In *International Handbook on the economics of corruption* (Susan Rose-Ackerman, ed.), Edward Elgar.

Bauer, Peter (1972), *Dissent on development*. Harvard University Press, Cambridge (Mass.).

Beblawi, Hazem (1990), "The rentier state in the arab world." In *The Arab State* (Giacomo Luciani, ed.), University of California Press, Berkeley.

Besley, Timothy and Robin Burgess (2002), "The political economy of government responsiveness: Theory and evidence from India." *The Quarterly Journal of Economics*, 117 (4), 1415–1451.

Besley, Timothy and Maitreesh Ghatak (2006), "Public goods and economic development." In *Understanding Poverty* (Abhijit Banerjee, Roland Benabou, and Dilip Mookherjee, eds.), Oxford University Press.

Besley, Timothy and Torsten Persson (2011), *Pillars of Prosperity: The Political Economics of Development Clusters*. Princeton University Press, Princeton, New Jersey.

Besley, Timothy and Torsten Persson (2013), "Taxation and development." In *Handbook of public economics* (Martin Feldstein Alan J. Auerbach, Raj Chetty and Emmanuel Saez, eds.), volume 5, 51–110, Elsevier.

Besley, Timothy and Torsten Persson (2014), "Why do developing countries tax so little?" *Journal of Economic Perspectives*, 28 (4), 99–120.

Björkman, Martina and Jakob Svensson (2009), "Power to the people: Evidence from a randomized field experiment on community-based monitoring in Uganda." *The Quarterly Journal of Economics*, 124 (2), 735–769.

Borge, Lars-Erik, Pernille Parmer, and Ragnar Torvik (2015), "Local natural resource curse?" Forthcoming, Journal of Public Economics.

Borge, Lars-Erik and Jørn Rattsø (2008), "Property taxation as incentive for cost control: Empirical evidence for utility services in Norway." *European Economic Review*, 52 (6), 1035–1054.

Brollo, Fernanda, Tommaso Nannicini, Roberto Perotti, and Guido Tabellini (2013), "The political resource curse." *American Economic Review*, 103 (5), 1759–1796.

Brutti, Zelda (2015), "Cities drifting apart: heterogeneous outcomes of decentralizing public education." Working Paper.

Cabral, Marika and Caroline Hoxby (2015), "The hated property tax: salience, tax rates and tax revolts." NBER Working Paper 18514.

Cameron, Colin, Jonah Gelbach, and Douglas Miller (2011), "Robust inference with multi-way clustering." *Journal of Business and Economic Statistics*, 29, 238–249.

Carreri, Maria and Oeindrila Dube (2015), "Do natural resources influence who comes to power, and how?" Working Paper.

Casaburi, Lorenzo and Ugo Troiano (2015), "Ghost-house busters: The electoral response to a large anti tax evasion program." *The Quarterly Journal of Economics*, Forthcoming.

Caselli, Francesco (2006), "Power struggles and the natural resource curse." Unpublished.

Caselli, Francesco and Tom Cunningham (2009), "Leader behaviour and the natural resource curse." *Oxford Economic Papers*, 61 (4), 628–650.

Caselli, Francesco and Guy Michaels (2013), "Do oil windfalls improve living standards? evidence from Brazil." *American Economic Journal: Applied Economics*, 5 (1), 208–38.

Chetty, Raj, Adam Looney, and Kory Kroft (2009), "Salience and taxation: Theory and evidence." *American Economic Review*, 99 (4), 1145–77.

Chong, Alberto, Ana De la O, Dean Karlan, and Leonard Wantchekon (2015), "Does corruption information inspire the fight or quash the hope? a field experiment in Mexico on voter turnout, choice and party identification." *The Journal of Politics*, 77 (1), 55–71.

Collier, Paul (2006), "Is aid oil? an analysis of whether Africa can absorb more aid." *World Development*, 34 (9), 1482 – 1497.

Cortés, Darwin (2010), "Do more decentralized local governments do better? an evaluation of the 2001 decentralization reform in Colombia." *Universidad del Rosario*, Documento de Trabajo 84.

De Janvry, Alain, Frederico Finan, and Elisabeth Sadoulet (2012), "Local electoral incentives and decentralized program performance." *The Review of Economics and Statistics*, 94 (3), 672–685.

De la O, Ana (2013), "Do conditional cash transfers affect electoral behavior? evidence from a randomized experiment in Mexico." *American Journal of Political Science*, 57 (1), 1–14.

Deaton, Angus (2013), *The great escape: health, wealth and the origin of inequality.* Princeton University Press, Princeton, NJ.

Dewatripont, Mathias, Ian Jewitt, and Jean Tirole (1999), "The economics of career concerns, part I: comparing information structures." *Review of Economic Studies*, 66 (1), 183–198.

Dollery, Brian E. and Andrew C. Worthington (1996), "The empirical analysis of fiscal illusion." *Journal of Economic Surveys*, 10 (3), 261–297.

Dube, Oeindrila and Juan F. Vargas (2013), "Commodity price shocks and civil conflict: Evidence from Colombia." *Review of Economic Studies*, 80 (4), 1384–1421.

Easterly, William (2006), *The white man's burden: Why the West's efforts to aid the rest have done so much ill and so little good*. Penguin, New York City.

Faguet, Jean-Paul (2014), "Decentralization and governance." *World Development*, 53, 2–13.

Faguet, Jean-Paul and Fabio Sánchez (2008), "Decentralization's effects on educational outcomes in Bolivia and Colombia." *World Development*, 36 (7), 1294–1316.

Faguet, Jean-Paul and Fabio Sánchez (2014), "Decentralization and access to social services in Colombia." *Public Choice*, 160 (1-2), 227–249.

Fehr, Ernst and Simon Gächter (2000), "Fairness and retaliation: The economics of reciprocity." *Journal of Economic Perspectives*, 14 (3), 159–181.

Fergusson, Leopoldo, Juan F. Vargas, and Mauricio Vela (2013), "Sunlight disinfects? free media in weak democracies." Documento CEDE 2013-14.

Ferraz, Claudio and Frederico Finan (2008), "Exposing corrupt politicians: The effects of Brazil's publicly released audits on electoral outcomes." *The Quarterly Journal of Economics*, 123 (2), 703–745.

Ferraz, Claudio and Frederico Finan (2011), "Electoral accountability and corruption: Evidence from the audits of local governments." *American Economic Review*, 101 (4), 1274–1311.

Ferraz, Claudio and Joana Monteiro (2014), "Learning to punish: Resource windfalls and political accountability in Brazil." Working Paper.

Finkelstein, Amy (2009), "E-ztax: Tax salience and tax rates." *The Quarterly Journal of Economics*, 124 (3), 969–1010.

Fisman, Raymond and Roberta Gatti (2002), "Decentralization and corruption: Evidence from U.S. federal transfer programs." *Public Choice*, 113 (1-2), 25–35.

Fujiwara, Thomas (2015), "Voting technology, political responsiveness, and infant health: Evidence from Brazil." *Econometrica*, 83 (2), 423–464.

Gadenne, Lucie (2015), "Tax me but spend wisely: Sources of public finance and government accountability." Working Paper.

Gadenne, Lucie and Monica Singhal (2014), "Decentralization in developing economies." *Annual Review of Economics*, 6 (1), 581–604.

Glaeser, Edward L. (1996), "The incentive effects of property taxes on local governments." *Public Choice*, 89 (1/2), 93–111.

Glaeser, Edward L. (2013), "Urban public finance." In *Handbook of public economics* (Martin Feldstein Alan J. Auerbach, Raj Chetty and Emmanuel Saez, eds.), volume 5, 195–256, Elsevier.

Guiteras, Raymond and Ahmed Mushfiq Mobarak (2014), "Does development aid undermine political accountability? leader and constituent responses to a large-scale intervention." Working Paper.

Herrera, Juan Camilo (2014), "Petróleo y desarrollo: Efectos en la acumulación y destrucción de capital humano de los municipios de Colombia." *Documento CEDE*, 2014 (10).

Holmström, Bengt (1999), "Managerial incentive problems: A dynamic perspective." *Review of Economic Studies*, 66 (1), 169–182.

Hoxby, Caroline (1999), "The productivity of schools and other local public goods producers." *Journal of Public Economics*, 74 (1), 1–30.

Idrobo, Nicolás, Daniel Mejía, and Ana María Tribín (2014), "Illegal gold mining and violence in Colombia." *Peace Economics*, 20 (1), 83–111.

Iregui, Ana María, Ligia Melo, and Jorge Ramos (2003), "El impuesto predial en Colombia: evolución reciente, comportamiento de las tarifas y potencial de recaudo." *Borradores de Economía 274*, Banco de la República.

Iregui, Ana María, Ligia Melo, and Jorge Ramos (2004), "El impuesto predial en Colombia: Factores explicativos del recaudo." *Borradores de Economía 319*, Banco de la República.

Leigh, Andrew (2009), "Does the world economy swing national elections?" *Oxford Bulletin of Economics and Statistics*, 71 (2), 163–181.

Litschig, Stephan and Kevin M. Morrison (2013), "The impact of intergovernmental transfers on education outcomes and poverty reduction." *American Economic Journal: Applied Economics*, 5 (4), 206–40.

Mahdavy, Hossein (1970), "The patterns and problems of economic development in rentier states: The case of Iran." In *Studies in the Economic History of the Middle East from the Rise of Islam to the present day* (M.A. Cook, ed.), Oxford University Press, London.

Maldonado, Stanislao (2014), "The political effects of resource booms: Political outcomes, clientelism and public goods provision in Peru." Working Paper.

Martin, Lucy (2014), "Taxation, loss aversion and accountability: Theory and experimental evidence for taxation's effect on citizen behavior." Working Paper.

Martínez-Bravo, Mónica, Gerard Padró i Miquel, Nancy Qian, and Yang Yao (2014), "Political reform in China: the effect of local elections." Working Paper.

Matsen, Egil, Gisle Natvik, and Ragnar Torvik (2015), "Petro Populism." Forthcoming, Journal of Development Economics.

Mehlum, Halvor, Karl Moene, and Ragnar Torvik (2006), "Institutions and the resource curse." *The Economic Journal*, 116 (508), 1–20.

Michaels, Guy (2011), "The long term consequences of resource-based specialisation." *The Economic Journal*, 121 (551), 31–57.

Miller, Grant and B. Piedad Urdinola (2010), "Cyclicality, mortality, and the value of time: The case of coffee price fluctuations and child survival in Colombia." *Journal of Political Economy*, 118 (1), 113–155.

Mookherjee, Dilip (2015), "Political decentralization." *Annual Review of Economics*, 7 (1), 231–249.

MPS (2005), "Política nacional de prestación de servicios de salud." Technical report, Ministerio de la Protección Social.

North, Douglass C. and Barry R. Weingast (1989), "Constitutions and commitment: The evolution of institutional governing public choice in seventeenth-century England." *The Journal of Economic History*, 49 (4), 803–832.

Núñez, Jairo (2005), "DiagnÓstico bÁsico de la situaciÓn de los ingresos por impuestos del orden municipal en Colombia." *Documento CEDE*, 2005 (44).

Oates, Wallace (2005), "Toward a second-generation theory of fiscal federalism." *International Tax and Public Finance*, 12, 349–373.

Olsson, Ola and Michele Valsecchi (2014), "Resource windfalls and public goods: Evidence from a policy reform in indonesia." Working Paper.

Paler, Laura (2013), "Keeping the public purse: An experiment in windfalls, taxes, and the incentives to restrain government." *American Political Science Review*, 107 (4), 706–725.

Persson, Torsten and Guido Tabellini (2000), *Political Economics: Explaining Economic Policy*. MIT Press, Cambridge (Mass.).

Pritchett, Lant and Yamini Aiyar (2014), "Value subtraction in public sector production: Accounting versus economic cost of primary schooling in India." *Center for Global Development Working Paper*, 2014 (391).

Reinikka, Ritva and Jakob Svensson (2004), "Local capture: Evidence from a central government transfer program in Uganda." *The Quarterly Journal of Economics*, 119 (2), 679–705.

Reinikka, Ritva and Jakob Svensson (2005), "Fighting corruption to improve schooling: Evidence from a newspaper campaign in Uganda." *Journal of the European Economic Association*, 3 (2-3), 259–267.

Robinson, James A., Ragnar Torvik, and Thierry Verdier (2006), "Political foundations of the resource curse." *Journal of Development Economics*, 79 (2), 447–468.

Ross, Michael L. (2001), "Does oil hinder democracy?" *World Politics*, 53, 325–361.

Ross, Michael L. (2004), "Does taxation lead to representation?" *British Journal of Political Science*, 34 (2), 229–249.

Santos, Rafael (2014), "Not all that glitters is gold: Gold boom, child labor and schooling in colombia." *Documento CEDE*, 2014 (31).

Snyder, James M. and David Strömberg (2010), "Press coverage and political accountability." *Journal of Political Economy*, 118 (2), 355–408.

Sánchez, Fabio and Irina España (2013), "Estructura, potencial y desafíos del impuesto predial en Colombia." *Documento CEDE*, 2013 (48).

Sánchez, Fabio and Jairo Núñez (2000), "La geografía y el desarrollo económico: Una aproximación municipal." *Desarrollo y Sociedad*, 46, 43–108.

Sánchez, Fabio and Mónica Pachón (2013), "Descentralización, esfuerzo fiscal y progreso social en Colombia en el nivel local, 1994-2009: ¿por qué importa la política nacional?" *Documento CEDE*, 2013 (38).

Sánchez, Fabio and Alexander Vega (2014), "Cobertura de acueducto y alcantarillado, calidad del agua y mortalidad infantil en Colombia, 2000-2012." *Documento CEDE*, 2014 (40).

Tribín, Ana María (2014), "Chasing votes with the public budget." Working Paper.

Vicente, Pedro C. (2010), "Does oil corrupt? evidence from a natural experiment in West Africa." *Journal of Development Economics*, 92 (1), 28–38.

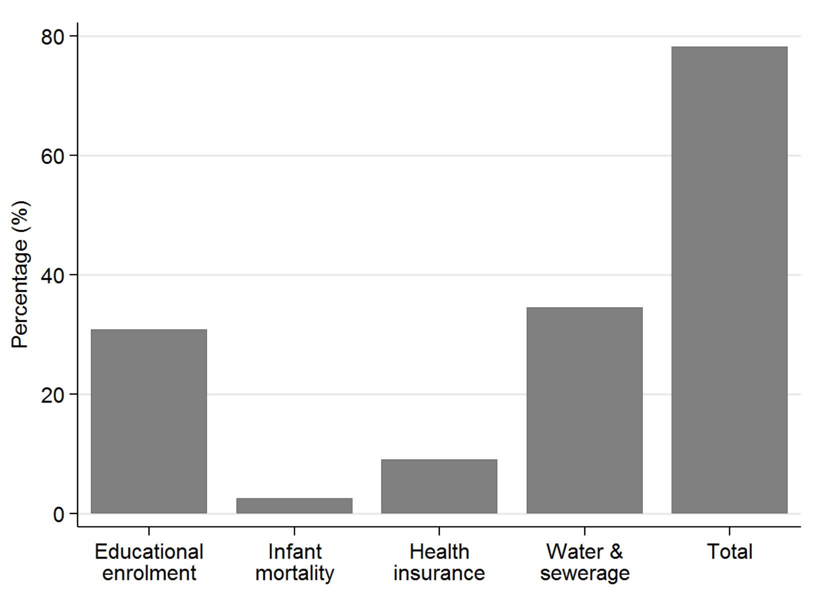
Weingast, Barry R. (2009), "Second generation fiscal federalism: The implications of fiscal incentives." *Journal of Urban Economics*, 65 (3), 279–293.

World Bank (2000), *World Development Report 1999/2000: Entering the 21st century*. Oxford University Press.

World Bank (2004), *World Development Report 2004: Making services work for poor people*. The World Bank and Oxford University Press.

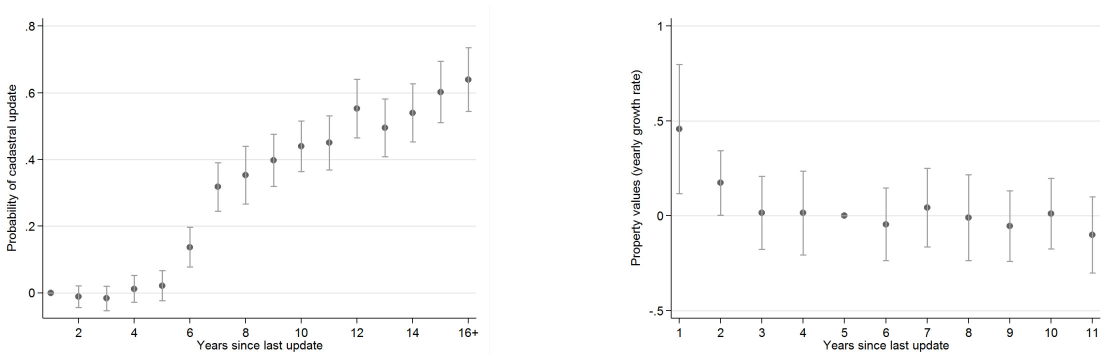
Zhuravskaya, Ekaterina V. (2000), "Incentives to provide local public goods: fiscal federalism, russian style." *Journal of Public Economics*, 76 (3), 337–368.

Figure 1: Royalties spent on targets for public services



Note: The graph shows the percentage of royalties spent on the attainment of each target (and the total) among 94 oil-royalty recipient municipalities in 2010 and 2011 (unbalanced panel). The graph shows percentages of the total expenditure but the results are very similar for average expenditure across municipalities.

Figure 2: Probability of a cadastral update and the implied annual growth rate in property values by age at time of update

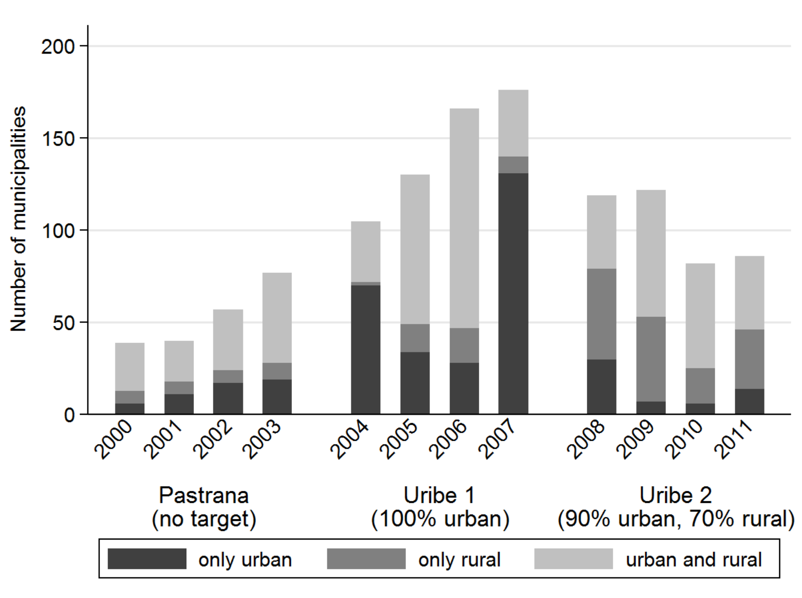


(a) Probability of Update

(b) Growth in Property Values

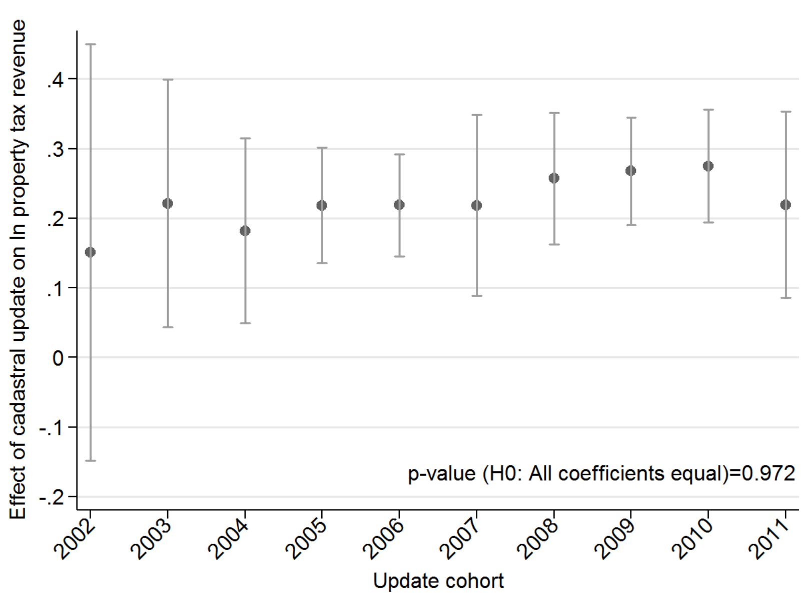
Note: Panel (a) shows results from a regression of the cadastral update dummy on a full set of indicators for the number of years since the previous update. The regression includes municipality and department-year fixed effects. Standard errors clustered two-way by municipality and department-year. Omitted category is one year after last update. Panel (b) shows results of a cross-sectional regression including only observations with a cadastral update. The implied growth rate in property values (based on the last update or year 2000) is regressed on a full set of the number of years since the last update. The regression includes department-year fixed effects. The standard errors are clustered by province. The omitted category is five years after last update.

Figure 3: Cadastral updates per year and presidential term



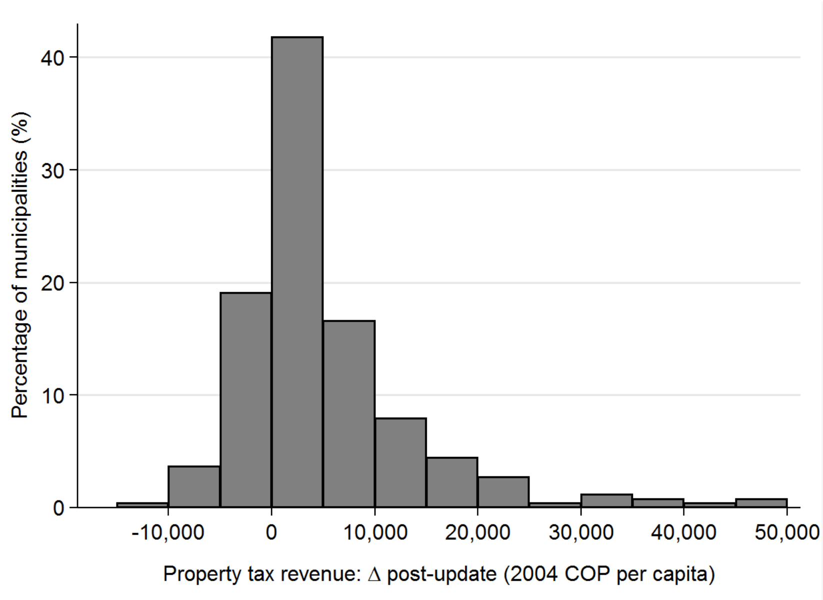
Note: I assign to each administration its first full calendar year (since presidential terms always start on August 7th) and the three following ones. Each term is then pushed back by one year to account for the fact that updated cadastres only come into effect the 1st of January of the following year.

Figure 4: Property tax revenue increases after a cadastral update by cohort



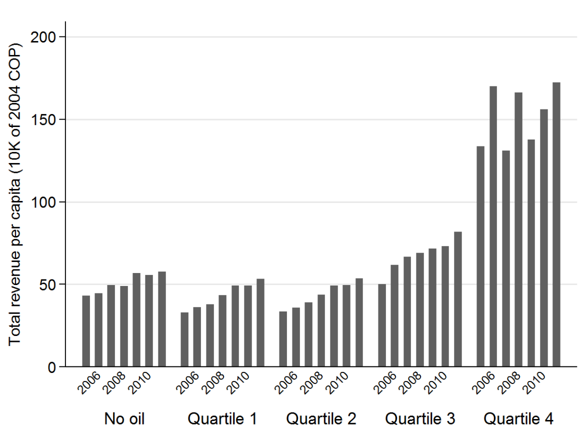
The graph shows point estimates and 95 % confidence intervals for a regression of ln property tax revenue per capita (2004 COP) on a set of dummies equal to one from year t onward if the municipality has a cadastral update on year t, weighted by the share of the cadastre that was updated (depending on whether the update was urban, rural or both). I use property values from 2000 to determine the shares. The regression includes municipality and department-year fixed effects. Standard errors clustered two-way by municipality and department-year.

Figure 5: Change in property tax revenue after a cadastral update

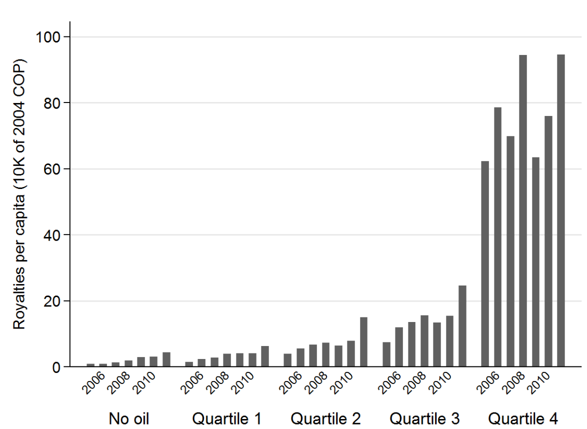


The graph shows the histogram for the difference between the average property tax revenue collected after a cadastral update and the amount for the year before the update. Top and bottom 1 % removed for ease of visualization. Property tax revenue in 2004 COP per capita. Update cohorts from 2006 to 2010. Pre-year corresponds to the first one in the case of multiple updates.

Figure 6: Total Revenue and Royalties by Oil intensity



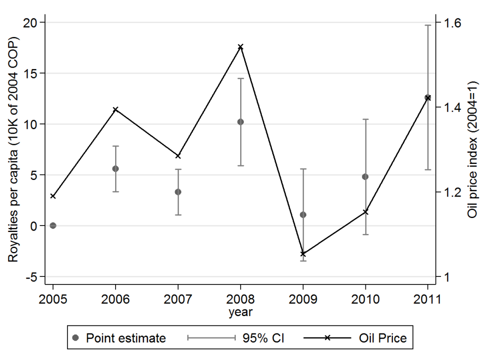
(a) Total revenue



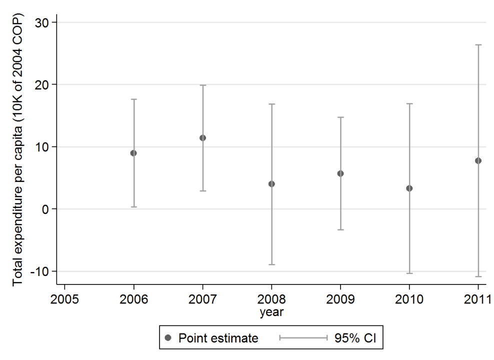
(b) Natural resource royalties

Note: The figures shows yearly averages of total revenue (panel A) and royalties (panel B) for each quartile of the 2000-2004 positive oil royalties distribution. It also shows this information for municipalities with no oil royalties between 2000 and 2004. All money values in tens of thousands of 2004 COP per capita.

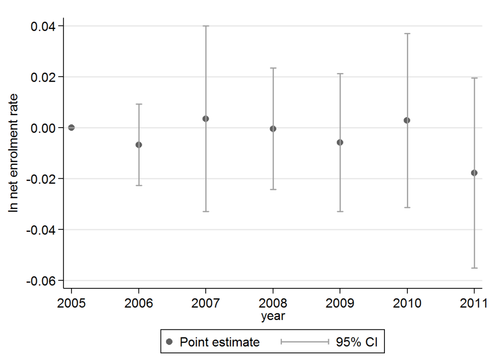
Figure 7: Medium-run impact of oil price shocks



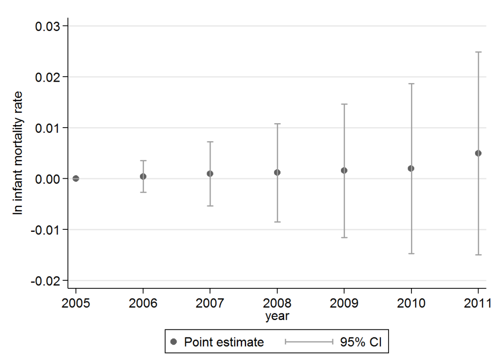
(a) Royalties



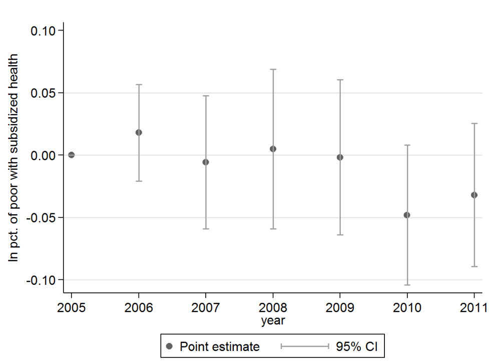
(b) Expenditure



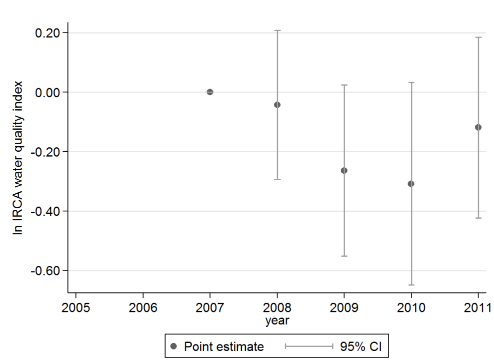
(c) Educational enrolment



(d) Infant mortality



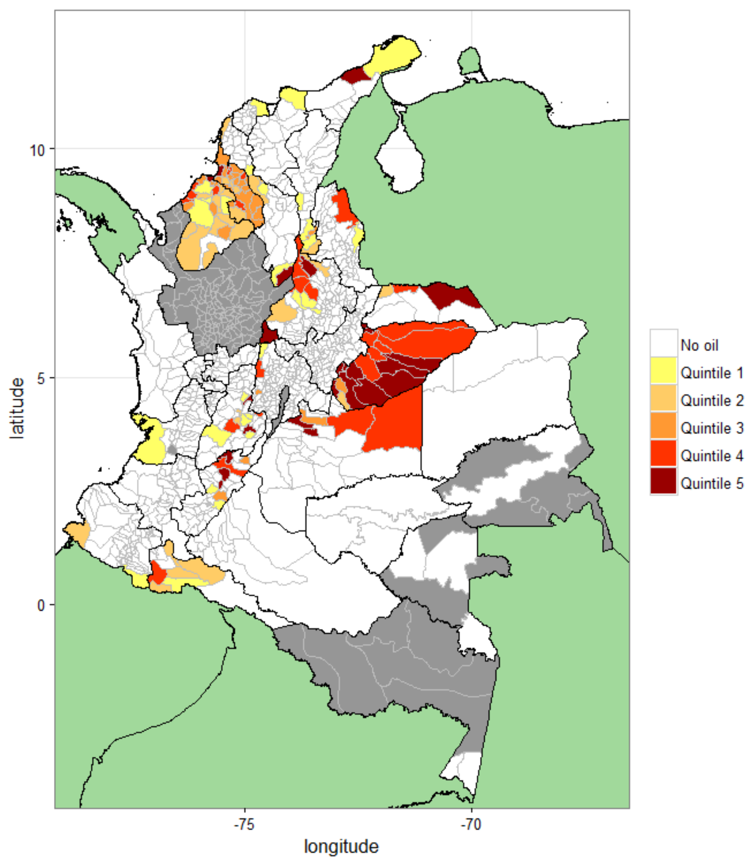
(e) Health insurance



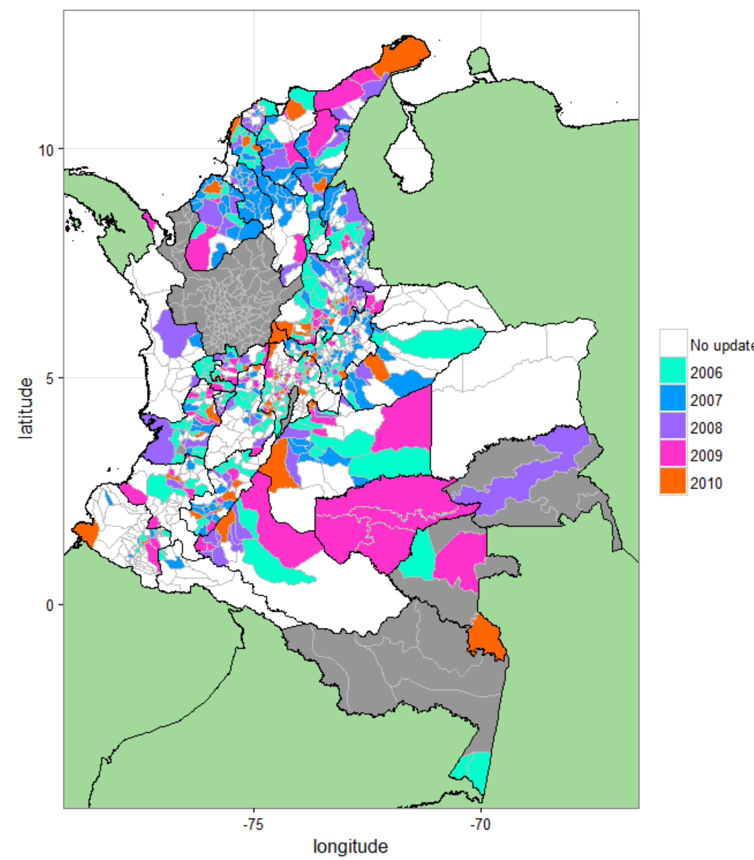
(f) Water quality

Note: Each graph shows point estimates and 95 % confidence intervals from a regression of the variable in the caption on a set of year interactions (2006-2011) with a dummy for municipalities with positive oil royalties between 2000 and 2004. These regressions use data from the period 2005-2011. All regressions include municipality and department-year fixed effects. Standard errors are clustered by province. In panel (a), the dark line shows the oil price index (2004=1), which I construct using the average petroleum spot price (IMF/IFS), the official exchange rate from Banco de la República and the Consumer Price Index calculated by DANE.

Figure 8: Municipalities with cadastral update and oil-royalty recipients



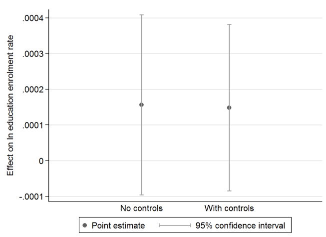
(a) Average oil royalties between 2000 and 2004



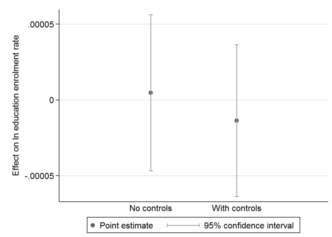
(b) Cadastral updates between 2006 and 2010

Note: Panel (a) shows average oil royalties between 2000-2004. Municipalities in white did not receive oil royalties in this period while the darker shades correspond to quintiles of the average oil-royalty distribution among royalty recipients. Panel (b) indicates the year in which municipalities had their first cadastral update in the period 2006-2010. In both maps, areas in grey correspond to municipalities that are excluded from the sample. This includes municipalities with their own cadastral agencies (Bogota, Medellin, Cali, Antioquia) and non-municipalized territories.

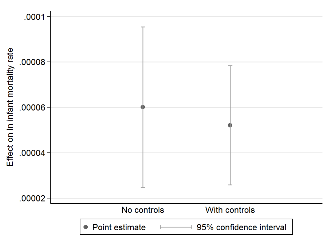
Figure 9: Impact of royalties with and without controls



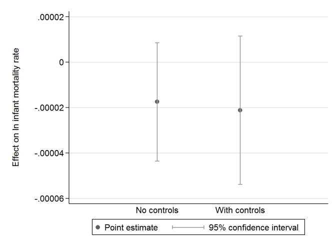
(a) Educational enrolment (t)



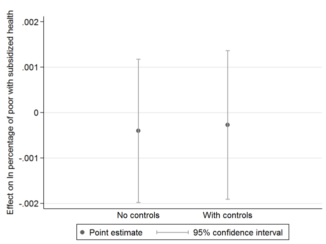
(b) Educational enrolment (cum.)



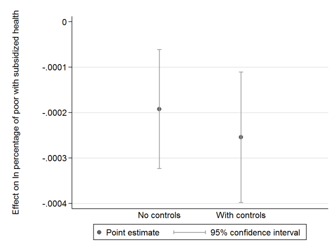
(c) Infant mortality (t)



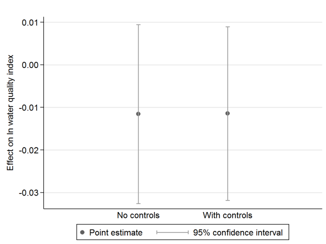
(d) Infant mortality (cum.)



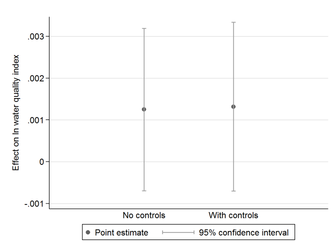
(e) Health insurance (t)



(f) Health insurance (cum.)



(g) Water quality (t)



(h) Water quality (cum.)

Note: Each graph shows point estimates and 95 % confidence intervals from a regression of the variable in the caption on natural resource royalties (tens of thousands of 2004 COP per capita). Panels on the left show IV results for contemporary royalties, where the instrumental variable is $\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t}$. Panels on the right show the results for cumulative royalties, instrumented using $\sum_{k=2006}^{t} \text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{k}$. All regressions use data from the period 2005-2010 and they all include municipality and department-year fixed effects. Standard errors are clustered two-way by municipality and department-year.

Table 1: Achievement of targets by oil-royalty recipients

Indicator	(1) Target[1]	(2) Mean (2005)	(3) Target met (% in 2005)
Net enrollment rate in basic education (%)	100	91.8	30.0
Infant mortality rate (‰)	16.5	26.8	7.1
Poor population with subsidized health insurance (%)	100	72.7	14.3
Water quality index (0-100)[2]	5	32.2	17.9
Population with access to drinking water (%)[3]	70	63.0	62.1
Population with access to sewerage (%)[3]	70	41.1	26.4

Notes: The table shows the indicators on which at least 75 % of royalties have to be spent and the targets that royalty recipients must meet. It also shows the average of each indicator in 2005 for the 140 municipalities with positive oil royalties between 2000 and 2004, as well as the percentage of these municipalities meeting the target. [1] Targets from Decree 1747/1995, modified by Law 1151/2007, Resolution 4911/2008 (Education) and Decree 1447/2010 (Water). [2] Information from 2007, which is the first year for which data on the IRCA water quality index is available. [3] Data on access to drinking water and sewerage is only available from the 2005 population census.

Table 2: Summary statistics of main variables

Variable	Mean	Std. Dev.	Min.	Max.	N
A. demographics					
Population (thousands)	30.03	75.55	0.88	1193.67	6,704
Rural share of population	0.58	0.24	0	0.98	6,704
B. cadastral updating					
Cadastral update (dummy)	0.13	0.34	0	1	6,704
Cadastral valuation (millions)	3.59	4.19	0	83.16	6,704
Number of properties (thousands)	9.10	20.26	0	304.51	6,704
C. oil price and royalties					
Oil royalties 2000-2004	2.36	16.4	0	348.47	969
Oil price (per barrel)	12.8	1.70	10.5	15.3	7
D. public finance					
Total revenue	54.35	43.21	8.88	637.52	6,704
Current revenue	13.93	11.97	1.59	212.96	6,704
Tax revenue	6.52	8.67	0.04	169.94	6,704
Property tax revenue	2.08	2.76	0	60.52	6,704
Capital revenue	40.42	35.61	3.29	567.87	6,704
Natural resource royalties	5.45	26.28	0	506.55	6,704
Transfers	35.89	23.26	5.02	553.46	6,704
Total expenditure	58.23	49.74	1.14	972.04	6,704
Current expenditure	8.46	10.98	0.08	776.33	6,704
Investment	49.78	45.02	0.66	931.36	6,704
E. development indicators					
Net enrolment rate in basic education (%)	88	17.18	18.7	244.4	6,704
Infant mortality rate (‰)	22.81	8.51	9.24	64.09	6,704
Poor population with subsidized health insurance (%)	87.15	15.66	0	100	6,704
IRCA water quality index (0-100)	29.38	23.82	0	100	4,472
F. disciplinary processes					
Mayor prosecuted (dummy)	0.19	0.39	0	1	2,985
Mayor found guilty (dummy)	0.14	0.34	0	1	2,985
Mayor banned from office (dummy)	0.08	0.28	0	1	2,985
Top staff prosecuted (dummy)	0.06	0.24	0	1	2,985
Top staff found guilty (dummy)	0.04	0.2	0	1	2,985
Top staff banned from office (dummy)	0.03	0.17	0	1	2,985
Council member prosecuted (dummy)	0.05	0.22	0	1	2,985
Council member found guilty (dummy)	0.04	0.2	0	1	2,985
Council member banned from office (dummy)	0.03	0.17	0	1	2,985

Note: The sample includes 969 municipalities for the period 2005-2011. Political characteristics in panel F are calculated using results from local elections in 2000, 2003 and 2007 and from national elections in 2002, 2006 and 2010. The variables related to disciplinary processes in panel E contain information from the local political periods 2001-2003, 2004-2007 and 2008-2011. All money variables are expressed in tens of thousands of 2004 Colombian pesos per capita, unless specified otherwise.

Table 3: Predicting a cadastral update

	No controls		Controls for recent updates			
Variable	Coefficient (1)	Standard error (2)	Coefficient (3)	Standard error (4)	Municipalities (5)	Observations (6)
ln population	0.279	(0.178)	0.0190	(0.195)	969	6,704
rural share of population	-0.764	(0.707)	-0.156	(0.617)	969	6,704
ln non-property tax revenue	0.00215	(0.00990)	0.0105	(0.00975)	969	6,704
ln total transfers	-0.0135	(0.0235)	0.0143	(0.0225)	969	6,704
natural resource royalties	3.79e-06	(2.70e-05)	-2.00e-06	(3.36e-05)	969	6,704
ln capital revenue	-0.0148	(0.0173)	-0.00397	(0.0166)	969	6,704
# candidates last mayor election	0.00407	(0.00413)	-0.00143	(0.00450)	968	6,160
vote share for winning mayor	0.0284	(0.0588)	0.0732	(0.0558)	968	6,160
HHI last mayor election (votes)	0.0231	(0.0608)	0.0436	(0.0582)	968	6,160
D(left-wing mayor)	0.0270	(0.0313)	0.0146	(0.0331)	968	6,160
D(Liberal mayor)	-0.00530	(0.0185)	0.00487	(0.0182)	968	6,160
D(Conservative mayor)	0.0220	(0.0179)	0.0272	(0.0167)	968	6,160
D(change of mayor's party)	-0.00149	(0.0200)	-0.000459	(0.0195)	790	5,432
parties/seat last council election	-0.0644*	(0.0391)	-0.0845**	(0.0367)	969	6,624
HHI last council election (seats)	-0.0638	(0.0648)	-0.0145	(0.0715)	969	6,624
share of council from mayor's party	-0.0548	(0.0375)	-0.0474	(0.0370)	965	6,136
share of council from left-wing parties	0.0148	(0.0710)	0.0270	(0.0731)	969	6,624
vote share for winning governor	0.0208	(0.0453)	0.0102	(0.0438)	969	6,678
D(mayor and governor from same party)	-0.0153	(0.0198)	0.00640	(0.0208)	968	6,154
vote share for winning president	0.00457	(0.0588)	0.0152	(0.0585)	969	6,670
HHI last House election (votes)	0.0549	(0.0617)	0.0229	(0.0586)	968	6,678
HHI last Senate election (votes)	0.0157	(0.0493)	0.00896	(0.0462)	968	6,678
D(Uribe visit)	0.0387	(0.0417)	0.0354	(0.0357)	969	6,704
new families in CCT program	0.000191	(0.000276)	0.000147	(0.000254)	969	6,704
value of new agricultural loans	2.72e-05	(8.88e-05)	6.73e-05	(9.40e-05)	969	6,704
D(municipality certified in education)	0.0320	(0.0750)	0.0370	(0.0823)	969	6,704
homicide rate	-0.000120	(0.000159)	-9.62e-05	(0.000160)	969	6,704
FARC events	-0.000452	(0.00168)	0.000264	(0.00151)	966	5,743
ELN events	-0.00375	(0.00324)	-0.00486	(0.00351)	966	5,743
D(coca crops)	-0.00913	(0.0316)	0.0192	(0.0309)	969	4,797

Each row corresponds to a different regression of a dummy equal to one the year before a cadastral update comes into effect on the respective variable. All regressions include municipality fixed effects and department-year fixed effects. Columns 3 and 4 show estimates from an enlarged specification that also includes as controls separate dummy variables for the first five years after an urban or rural update. Standard errors clustered two-way by municipality and by department-year. The number of observations varies due to data availability. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: First stage results

VARIABLES	(1) Property Tax	(2) Royalties	(3) Royalties (cumulative)
$D(\text{post-cadastral-update})_{i,t}$	0.629***		
	[0.126]		
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_t$		0.851***	
		[0.184]	
$\sum_{k=2006}^{t} \text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_k$			0.806***
			[0.0584]
Dependent variable mean	2.075	5.449	34.233
- if oil-royalty recipient (00-04)	-	24.861	166.768
Observations	6,704	6,704	6,704
Number of municipalities	969	969	969

Dependent variable in the header. Money variables in tens of thousands of 2004 COP per capita. All regressions include municipality and department-year fixed effects. Sample period: 2005-2011. Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Sources of revenue and public good provision

	natural log [columns 1-4]				D(target achievement) [columns 5-8]			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Educational enrolment	Infant mortality	Health insurance	Water quality	Educational enrolment	Infant mortality	Health insurance	Water quality
				PANEL A: REDUCED FORM				
D(post-cadastral-update)$_{i,t}$	0.00886***	0.00295	0.0120	0.123**	0.0133	-0.000557	0.0313*	0.0760***
	[0.00334]	[0.00210]	[0.00850]	[0.0560]	[0.0134]	[0.0109]	[0.0174]	[0.0219]
royalties$^{oil}_{i,00-04}$ × price$^{oil}_{t}$	0.000119	1.87e-05	-0.000419	0.0112*	0.00136*	7.26e-05	-0.00178	0.00275
	[0.000101]	[2.27e-05]	[0.000751]	[0.00626]	[0.000820]	[7.75e-05]	[0.00142]	[0.00356]
				PANEL B: IV				
property tax revenue$_{i,t}$	0.0142**	0.00472	0.0189	0.145*	0.0220	-0.000855	0.0491*	0.0897***
	[0.00616]	[0.00357]	[0.0136]	[0.0778]	[0.0209]	[0.0174]	[0.0288]	[0.0285]
natural resource royalties$_{i,t}$	0.000231	5.23e-05	-0.000372	0.0113	0.00175	7.99e-05	-0.00177	0.00317
	[0.000162]	[3.93e-05]	[0.000851]	[0.00805]	[0.00118]	[0.000164]	[0.00189]	[0.00376]
1st stage F-statistic	14.604	14.604	14.604	8.126	14.604	14.604	14.604	8.126
p-value H0:tax=royalties	0.022	0.187	0.156	0.086	0.325	0.957	0.074	0.0002
Dependent variable mean in 2005 (level)	86.1	24.2	74.3	30.5	0.15	0.16	0.15	0.18
Observations	6,704	6,704	6,704	4,467	6,704	6,704	6,704	4,467
Number of municipalities	969	969	969	937	969	969	969	937

Dependent variable in the header: in columns 1-4 the dependent variable is in natural log, while in columns 5-8 it is a dummy for target achievement. Money variables in tens of thousands of 2004 COP per capita. In panel B, D(post-cadastral-update) and royalties$^{oil}_{i,00-04}$ × price$^{oil}_{t}$ are used as instruments for property tax revenue and natural resource royalties, respectively. All regressions include municipality-term and department-year fixed effects (sample period: 2005-2011, except column 4: 2007-2011). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Heterogeneous effect of cadastral updates for oil-royalty recipients

VARIABLES	(1) Educational enrolment	(2) Infant mortality	(3) Health insurance	(4) Water quality
PANEL A: NATURAL LOG				
D(post-cadastral-update)$_{i,t}$	0.00897***	0.00318	0.0127	0.122**
	[0.00333]	[0.00211]	[0.00863]	[0.0558]
D(post-cadastral-update)$_{i,t}$ × royalties$^{oil}_{i,00-04}$	-4.48e-05	-7.61e-05	-0.000185	-0.00140
	[0.00109]	[0.000873]	[0.00284]	[0.0312]
p-value H0: effect for median non-zero oil royalties=0	0.009	0.174	0.163	0.040
p-value H0: effect for mean non-zero oil royalties=0	0.021	0.375	0.259	0.126
PANEL B: D(TARGET ACHIEVEMENT)				
D(post-cadastral-update)$_{i,t}$	0.0149	-0.000777	0.0309*	0.0751***
	[0.0133]	[0.0110]	[0.0174]	[0.0221]
D(post-cadastral-update)$_{i,t}$ × royalties$^{oil}_{i,00-04}$	-0.000611	6.54e-05	0.000257	-0.000145
	[0.000837]	[0.000111]	[0.000515]	[0.00113]
p-value H0: effect for median non-zero oil royalties=0	0.365	0.964	0.064	0.001
p-value H0: effect for mean non-zero oil royalties=0	0.792	0.978	0.057	0.008
Observations	6,704	6,704	6,704	4,467
Number of municipalities	969	969	969	937

Notes: Dependent variable in the header. The mean of non-zero 2000-2004 average oil royalties is 16.45, the median is 4.39 (tens of thousands of 2004 COP). All regressions include municipality and department-year fixed effects (sample period: 2005-2011 except column 4: 2007-2011). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Additional effects of oil price shocks

VARIABLES	(1) ln population	(2) Business tax	(3) Murder rate	(4) FARC events
	PANEL A: REDUCED FORM (t)			
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t}$	-8.76e-06	0.0268	-0.146**	0.0277***
	[8.93e-05]	[0.0226]	[0.0664]	[0.00669]
	PANEL B: REDUCED FORM (cumulative)			
$\sum_{k=2006}^{t} \text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{k}$	6.42e-05***	0.00943***	-0.00354	0.00143
	[1.53e-05]	[0.00261]	[0.0122]	[0.00134]
Observations	6,704	6,704	6,704	5,743
Number of municipalities	969	969	969	966
Dependent var. mean	30,026.40	1.60	33.87	1.37

Dependent variable in the header. Money variables in tens of thousands of 2004 COP per capita. All regressions include municipality and department-year fixed effects (sample period: 2005-2011, except column 4: 2005-2010). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Sources of revenue and public expenditure

VARIABLES	(1)	(2) Contemporary expenditure	(3)	(4) Expenditure (cumulative)
		PANEL A: TOTAL EXPENDITURE		
property tax revenue$_{i,t}$	1.335		1.779	
	[2.266]		[2.014]	
natural resource royalties$_{i,t-1}$		0.629	0.646	
		[0.529]	[0.544]	
natural resource royalties (cum.)$_{i,t}$				1.179***
				[0.117]
p-value H0: coefficient = 1	0.882	0.482		0.127
p-value H0: tax=royalties = 1			0.645	
		PANEL B: INVESTMENT		
property tax revenue$_{i,t}$	1.165		1.593	
	[2.172]		[1.924]	
natural resource royalties$_{i,t-1}$		0.608	0.623	
		[0.516]	[0.530]	
natural resource royalties (cum.)$_{i,t}$				1.125***
				[0.113]
p-value H0: coefficient = 1	0.939	0.447		0.272
p-value H0: tax=royalties = 1			0.647	
		PANEL C: OPERATING EXPENSES		
property tax revenue$_{i,t}$	0.157		0.174	
	[0.252]		[0.254]	
natural resource royalties$_{i,t-1}$		0.0229	0.0246	
		[0.0206]	[0.0218]	
natural resource royalties (cum.)$_{i,t}$				0.0535***
				[0.00639]
p-value H0: coefficient = 1	0.001	0.000		0.000
p-value H0: tax=royalties = 1			0.000	
Observations	6,704	6,704	6,704	6,704
Number of municipalities	969	969	969	969
1st stage F-statistic	23.999	22.725	14.047	184.161

Notes: Dependent variable is total expenditure per capita in panel A, investment in panel B and operating expenses in panel C. Contemporary values of expenditure in columns 1-3, cumulative in column 4. Money variables in tens of thousands of 2004 COP per capita. All regressions include municipality and department-year fixed effects. The instrument for lagged royalties is $\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t-1}$ (columns 2,3), and for cumulative royalties it is $\sum_{k=2006}^{t} \text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{k}$ (column 4). D(post-cadastral-update) is the instrument for property tax revenue. Sample period: 2005-2011. Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table 9: Sources of revenue and educational infrastructure

VARIABLES	(1) Schools	(2) Schools per 10,000 inh.	(3) Teaching area	(4) Teaching area per 10,000 inh.
	PANEL A: REDUCED FORM			
D(post-cadastral-update)$_{i,t}$	0.904**	0.198	995.3	74.22
	[0.439]	[0.147]	[1,133]	[236.9]
royalties$^{\text{oil}}_{i,00-04}$ × price$^{\text{oil}}_{t}$	-0.00184	0.00156	53.91	61.64
	[0.00509]	[0.00143]	[56.12]	[65.63]
	PANEL B: IV			
property tax revenue$_{i,t}$	1.44*	0.317	1,210	166.2
	[0.744]	[0.252]	[1,332]	[282.1]
natural resource royalties$_{i,t}$	0.00710	0.00387	69.28	77.21
	[0.0106]	[0.00364]	[63.81]	[66.75]
1st stage F-statistic	14.604	14.604	5.944	5.944
p-value H0:tax=royalties	0.054	0.213	0.399	0.804
Observations	6,704	6,704	3,882	3,882
Number of municipalities	969	969	871	871
Dependent variable mean	47.69	27.93	10,010.2	4,852.09

Dependent variable in the header. Money variables in tens of thousands of 2004 COP per capita. In panel B, D(post-cadastral-update) and royalties$^{\text{oil}}_{i,00-04}$ × price$^{\text{oil}}_{t}$ are used as instruments for property tax revenue and natural resource royalties, respectively. All regressions include municipality and department-year fixed effects. Sample period: 2005-2011 (columns 1 and 2), 2006-2011 (columns 3 and 4). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Sources of revenue and disciplinary processeses

VARIABLES	(1) D(Mayor prosecuted)	(2) D(Mayor guilty)	(3) D(Mayor discharged)	(4) D(Top staff prosecuted)	(5) D(Top staff guilty)	(6) D(Top staff discharged)
PANEL A: REDUCED FORM						
number of updates	-0.000634	-0.00253	-0.00707	0.00512	-0.00247	-0.00883
	[0.0370]	[0.0336]	[0.0258]	[0.0232]	[0.0178]	[0.0148]
$\text{royalties}_{i,2000} \times \text{price}^{\text{oil}}_{i,t}$	0.0254**	0.0220*	0.0144**	0.0151***	0.00971	0.0109
	[0.0116]	[0.0119]	[0.00699]	[0.00576]	[0.00597]	[0.00663]
PANEL B: IV						
total property tax revenue	-0.0110	-0.0156	-0.0267	0.0102	-0.0110	-0.0309
	[0.115]	[0.104]	[0.0789]	[0.0710]	[0.0544]	[0.0446]
total royalties	0.0103**	0.00895*	0.00584**	0.00616***	0.00394*	0.00439*
	[0.00511]	[0.00516]	[0.00260]	[0.00185]	[0.00221]	[0.00227]
p-value H0:tax=royalties	0.853	0.815	0.678	0.955	0.785	0.432
Observations	2,888	2,888	2,888	2,888	2,888	2,888
Number of municipalities	964	964	964	964	964	964
Dependent variable mean	0.19	0.14	0.08	0.06	0.04	0.03

Dependent variable in the header. The dependent variables are dummies indicating if a disciplinary process involving the official was opened, whether the official was found guilty and whether the official was discharged from office. Columns 1-3 look at mayors, while columns 4-6 look at top executive staff. Panel A shows reduced form results, while panel B shows IV estimates, where predicted royalties (oil royalties in 2000 x oil price index) and the cumulative number of cadastral updates (weighted by share of cadastre updated) are used as instruments for total royalties and total property tax revenue (Hundreds of thousands of 2004 COP per capita). The first stage F-statistic is 16.35. All regressions include municipality and department-term fixed effects (2004-2007, 2008-2011). Robust standard errors clustered by municipality and department-term in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 11: Sources of revenue and social mobilizations

VARIABLES	(1) Social Mobilization	(2) Demonstration	(3) Demonstration (Pub. Services)	(4) Strike
	PANEL A: REDUCED FORM			
D(post-cadastral-update)$_{i,t}$	0.0118	0.00686	0.0101	-0.000223
	[0.0138]	[0.0113]	[0.00882]	[0.00453]
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_t$	-0.000739	-0.000344	-2.34e-05	-0.000845
	[0.000845]	[0.000285]	[0.000116]	[0.000532]
	PANEL B: IV			
property tax revenue$_{i,t}$	0.0185	0.0108	0.0161	-0.000784
	[0.0225]	[0.0183]	[0.0146]	[0.00738]
natural resource royalties$_{i,t}$	-0.000751	-0.000336	7.58e-05	-0.000999
	[0.000949]	[0.000354]	[0.000199]	[0.000615]
p-value H0:tax=royalties	0.389	0.541	0.268	0.976
Dependent variable mean	0.078	0.048	0.028	0.005
Observations	6,704	6,704	6,704	6,704
Number of municipalities	969	969	969	969

Dependent variable in the header. Money variables in tens of thousands of 2004 COP per capita. In panel B, D(post-cadastral-update) and $\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_t$ are used as instruments for property tax revenue and natural resource royalties, respectively. The first stage F-statistic is 14.6. All regressions include municipality and department-year fixed effects. Sample period: 2005-2011. Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

SUPPLEMENTARY APPENDIX

Appendix A Theoretical Appendix

A.1 Set-up of the model and equilibrium

This is a two-period model in which a citizen/voter obtains utility from private consumption of her disposable income and also from consumption of a public good. At the end of the first period an election between the incumbent and a random opponent takes place. The incumbent as well as his opponent are drawn from a pool of potential politicians, each endowed with some level of ability $\theta_i > 0$. The ability of all politicians is unknown to everyone but there is a common prior that is normally distributed with mean m and precision h.

The citizen receives a constant income $y_t = y$ each period. She pays a tax on the fraction of her income $\eta \in (0, 1)$ at an exogenous rate $\tau \in (0, 1)$. The citizen's private consumption is equal to her disposable income: $c_t = (1 - \tau\eta)y_t$. Her utility function is $U_t = U(c_t, g_t)$, where g_t is the amount of the public good that is supplied that period. $U(\cdot)$ is increasing in both of its arguments.

Government revenue (R_t) is equal to tax revenue (amounting to $\tau\eta y_t$) plus revenue from an external source (T_t) such as royalties from the extraction of natural resources or transfers from another level of government. I assume that operational expenditures eat up the constant share of revenue $1 - \mu$, so the amount of revenue available for public good provision is μR_t, $\mu \in (0, 1)$.

The amount of public good provided by the mayor with ability level θ at time $t \in \{1, 2\}$ is given by the function

$$g_t = \theta + \mu R_t + e_t \tag{5}$$

where $R_t = \tau\eta y_t + T_t$ and $e_t \geq 0$ is the amount of effort put in by the mayor, which is unobservable to the citizen.[33] The cost of effort borne by the mayor is given by the increasing and strictly convex function $\gamma C(e), \gamma > 0$. The mayor also gets a benefit $E > 0$ from being in power each period, which includes financial rewards and "ego rents". Total per-period utility for the mayor is then $E - \gamma C(e)$.

At the end of the first period the citizen observes the amount of public good provided. She also receives a noisy signal ($\tilde{R}_t$) on the total amount of revenue (R_t). I assume that the signal is equal to the actual revenue minus a mean-zero normally distributed noise term: $\tilde{R}_t = R_t + \epsilon_t^R$ where $\epsilon_t^R \sim N[0, 1/h_R^\epsilon]$ Based on this information and a conjecture on effort she updates her beliefs on the incumbent's ability. She then votes for the candidate of her

[33] See Dewatripont et al. (1999) for a discussion of more general versions of this type of model.

liking.

Before making additional assumptions about the link between the sources of revenue and the noisy signal that the citizen receives, I summarize the timing of the game (I will drop the time subscripts for everything that is not changing over time):

1. The incumbent (with ability θ_I unknown to all) receives revenue $R = T + \tau\eta y$ and chooses the amount of effort e_1.

2. A quantity of public goods g_1 is provided according to equation 5.

3. The citizen observes g_1 and receives the noisy signal $\tilde{R}$. She uses this information to update her beliefs on the incumbent's ability: $\hat{\theta}_I$.

4. The citizen votes either for the incumbent or for a random opponent with the same prior ability (m).

5. The winner of the election chooses e_2 and this determines g_2.

We can find the PBE in pure strategies using backwards induction. The winning candidate (with ability θ_2) solves the following problem in the second period:

$$\max_{e_2 \geq 0} \quad E - \gamma C(e_2)$$

Since $\gamma C(\cdot)$ is an increasing function, the second-period mayor will set $e_2^\star = 0$ and will get utility E that period. Therefore, the amount of public good provided will be $g_2^\star(\theta_2) = \theta_2 + \mu R$, which is an increasing function of the ability of the second-period mayor. If the voter chooses a candidate with believed ability $\hat{\theta}$, her second period utility is $U(c_2, g_2^\star(\hat{\theta})) = U(1 - \tau\eta y, \hat{\theta} + \mu R)$. Since $U(\cdot)$ is increasing in g_2, the incumbent will be re-elected only if the voter believes him to have higher ability than the opponent. That is, if $\hat{\theta}_I \geq m$.

The citizen updates her beliefs on the incumbent's ability based on the amount of first-period public goods (g_1), her conjecture on the level of effort put in by the incumbent ($\hat{e}_1$), and the noisy signal on revenue ($\tilde{R}$). The problem that the citizen faces is that the discrepancy between the observed amount of public goods and the amount she expected, which I will label $Z_1 \equiv g_1 - \mu\tilde{R} - \hat{e}_1$, is equal to the incumbent's ability (θ_I) minus the noise term's impact on expected public goods ($\mu\epsilon_t^R$). Given that θ_I and $\mu\epsilon_t^R$ are two independent normally distributed random variables, the solution to the signal extraction problem is:

$$\hat{\theta}_I = E[\theta_I | Z_1] = \frac{mh + Z_1 h_R}{h + h_R} \tag{6}$$

This expression says that the posterior belief on the incumbent's ability is a weighted average of the prior m and the discrepancy Z_1, where the respective weights are given by the precision of the prior (h) and of the noise term ($h_R = h_R^\epsilon/\mu^2$). As the signal gets noisier ($h_R \to 0$), it becomes less informative and the posterior gets closer to the prior. Similarly, as the signal gets more precise ($h_R \to \infty$) it perfectly reveals the incumbent's ability and full updating occurs (all the discrepancy is attributed to ability). Equation 6 implies that the re-election condition simplifies to $Z_1 \geq m$.

From the incumbent's perspective, his probability of re-election is:

$$\begin{aligned} p_I(e_1) &= \text{prob}(g_1 - \mu\tilde{R} - \hat{e}_1 \geq m) \\ &= \text{prob}(\theta + \mu R + e_1 - \mu R - \mu\epsilon_t^R - \hat{e}_1 \geq m) \\ &= \text{prob}(\theta - \mu\epsilon_t^R \geq m + \hat{e}_1 - e_1) \\ &= \text{prob}(Z_1 \geq m + \hat{e}_1 - e_1) \\ &= 1 - \Phi_Z(m + \hat{e}_1 - e_1) \end{aligned}$$

where Φ is the cumulative distribution function of the normally distributed Z_1, which has mean m and precision $h_Z \equiv \frac{h \cdot h_R}{h + h_R}$. The expression above tells us that the incumbent can increase his probability of re-election by increasing the amount of effort (e_1) relative to the voter's conjecture ($\hat{e}_1$). Therefore, the problem solved by the incumbent in period 1 is:

$$\max_{e_1 \geq 0} \quad E - \gamma C(e_1) + (1 - \Phi_Z(m + \hat{e}_1 - e_1))\, \beta E$$

Assuming an interior solution, the first-order condition of this problem is:

$$\gamma C'(e_1^\star) = \phi_z(m + \hat{e}_1 - e_1^\star)\beta E$$

where ϕ_z is the probability density function of Z_1. Given that in equilibrium $\hat{e}_1 = e_1^\star$, the first-order condition characterizing optimal first-period effort simplifies to:[34]

$$\gamma C'(e_1^\star) = \frac{\beta E}{\sqrt{2\pi/h_Z}} \tag{7}$$

As equation 7 shows, $e_1^\star$ does not depend on revenue. Hence, a \$1 increase from either source has a mechanical and homogeneous effect of size μ on public good provision.[35] Equa-

[34]The equilibrium re-election probability is thus $1 - \Phi_z(m) = 1/2$ since m is the mean of the normally distributed Z_1.

[35]In a modified version of the model, in which the incumbent's choice is over private rents rather than effort, revenue does have a positive effect (the electoral cost of a fixed amount of rents decreases as revenue increases), but this effect is still homogeneous across sources. See Persson and Tabellini (2000), Alesina and

tion 7 also shows that $e_1^\star$ is an increasing function of h_Z (since $C(e)$ is strictly convex), which is itself an increasing function of the precision of the revenue signal h_R. Hence, as the signal becomes more precise, the voter becomes more attentive to public good provision and the incumbent provides more effort in equilibrium.

A.2 Taxes as a source of information on public revenue

Having solved the model, I now examine two extensions that link the source of revenue to the precision of the revenue signal and yield predictions of a heterogeneous effect of revenue from different sources on incumbent effort and public good provision. I start by assuming that the share of exogenous revenue amplifies the noise in the voter's signal:

Assumption 1. $\tilde{R}_t = R_t - \epsilon_t^R$ *where* $\epsilon_t^R = \epsilon_t \times \left(\frac{T}{T+\tau\eta y}\right)^{\frac{1}{2}}$ *and* $\epsilon_t \sim N[0, 1/h_\epsilon]$

Hence, the precision of the revenue signal is $h_R = \left(\frac{T+\tau\eta y}{T}\right)\frac{h_\epsilon}{\mu^2}$. This assumption captures the idea that citizens are better informed about changes in tax revenue than about changes in external revenue. Now, as tax revenue increases, the signal becomes more precise and the citizen becomes more attentive to the amount of public goods provided in her assessment of the incumbent's quality. This in turn makes it optimal for the incumbent to increase effort in order to influence the election in his favour. By the same logic, an increase in exogenous revenue makes the revenue signal noisier and the citizen less responsive, so the incumbent reduces effort.

As before, the functional form of the production function for public goods implies that revenue from any source has a mechanical effect on public good provision. However, the total or net effect of a revenue increase depends also on the indirect effect through incumbent effort. Under assumption 1, an increase in tax revenue has a larger effect on public good provision than an equivalent increase in external revenue due to the opposite indirect effect through incumbent effort. The following proposition formalizes this result.

Proposition 1. *Under assumption 1, the equilibrium first-period effort of the incumbent is increasing in tax revenue and decreasing in external revenue. Hence, public good provision in the first period increases by more than the mechanical revenue effect when there is an increase in tax revenue and by less than the mechanical revenue effect when there is an increase in external revenue.*

Tabellini (2007), Brollo et al. (2013) or Matsen et al. (2015) for examples. If the incumbent is unconstrained on the amount he can appropriate, extra revenue has the additional effect of increasing the value of staying in power. This mechanism is at play in the model of the resource curse in Robinson et al. (2006). Still, this does not give rise to any heterogeneity across sources.

Proof. Using the implicit function theorem and noting that $C(\cdot)$ is a strictly convex function, when we differentiate (7) with respect to $\tau\eta y$ we obtain:

$$\gamma \frac{\partial^2 C}{\partial e_1^{\star 2}} \frac{\partial e_1^\star}{\partial \tau\eta y} = \frac{\partial \phi_Z}{\partial h_Z} \frac{\partial h_Z}{\partial \tau\eta y} \beta E \tag{8}$$

From $\phi_Z = \sqrt{h_Z/2\pi}$ we can see that $\partial\phi_Z/\partial h_Z > 0$. Using the definitions of h_Z and h_R we find that

$$\frac{\partial h_Z}{\partial \tau\eta y} = \frac{(\mu h)^2 h_\epsilon T}{\left(h_\epsilon(T+\tau\eta y) + \mu^2 hT\right)^2} > 0$$

Since all other terms on both sides of equation 8 are positive, $\frac{\partial e_1^\star}{\partial \tau\eta y} > 0$. Hence, the overall effect of a tax revenue increase on first-period public good provision, based on equation 1, is given by

$$\frac{\partial g_1^\star}{\partial \tau\eta y} = \mu + \frac{\partial e_1^\star}{\partial \tau\eta y} > \mu$$

where μ is the mechanical revenue effect.

Using again implicit differentiation on equation (7) but with respect to T we get

$$\gamma \frac{\partial^2 C}{\partial e_1^{\star 2}} \frac{\partial e_1^\star}{\partial T} = \frac{\partial \phi_Z}{\partial h_Z} \frac{\partial h_Z}{\partial T} \beta E \tag{9}$$

The argument works the same as in the case of taxes, except that now

$$\frac{\partial h_Z}{\partial T} = \frac{-(\mu h)^2 h_\epsilon \tau\eta y}{\left(h_\epsilon(T+\tau\eta y) + \mu^2 hT\right)^2} < 0$$

Since all the other terms on both sides of equation 9 are positive, $\frac{\partial e_1^\star}{\partial T} < 0$. Therefore, the overall effect of an increase in exogenous revenue on first-period public good provision is given by

$$\frac{\partial g_1^\star}{\partial T} = \mu + \frac{\partial e_1^\star}{\partial T} < \mu < \frac{\partial g_1^\star}{\partial \tau\eta y}$$

where again μ is the mechanical revenue effect.

□

A.3 Taxes as an incentive for information acquisition on public revenue

I now substitute Assumption 1 with the following three assumptions:

Assumption 2. $\tilde{R}_t = R_t + \epsilon_t^R$, *where* $\epsilon_t^R \sim N[0, 1/h_R^\epsilon]$

Assumption 3. $U_t = U(c_t + \alpha g_t)$ *where* $U(\cdot)$ *is a strictly concave function and* $\alpha \in (0, 1/\mu)$

Assumption 4. *At the start of the game, the voter can choose how much effort* ($f_1 \geq 0$) *to spend on the improvement of the revenue signal. Effort increases the precision of the revenue signal according to the linear function* $h_R^\epsilon = \lambda f_1$, $\lambda > 0$, *but has a cost given by the strictly convex function* $K(f_1)$

Under assumptions 2-4 the model is essentially unchanged: the incumbent's first-period effort is still determined by (7) and is increasing on the precision of the revenue signal.

If we substitute the public good production function and the voter's budget constraint into her first-period utility function we can see that the problem the voter solves is

$$\begin{aligned}\max_{f_1 \geq 0} U_1 &= U(c_1 + \alpha g_1) - K(f_1) \\ &= U[(1 - \tau\eta)y + \alpha\left(\theta_I + \mu(\tau\eta y + T) + e_1^\star(h_Z)\right)] - K(f_1) \\ &= U[y + (\alpha\mu - 1)\tau\eta y + \alpha\mu T + \alpha\theta_I + \alpha e_1^\star(h_Z)] - K(f_1)\end{aligned}$$

Assuming an interior solution, the optimal amount of voter effort is implicitly defined by the following first-order condition:

$$U'[y + (\alpha\mu - 1)\tau\eta y + \alpha\mu T + \alpha\theta_I + \alpha e_1^\star(h_Z)]\alpha\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}\lambda = K'(f_1^\star) \tag{10}$$

Just like before, the voter is more responsive to public good provision in her assessment of the incumbent's quality the better she is informed about revenue. In turn, the incumbent puts in more effort as the voter becomes more responsive. Under the new assumptions, what sets this mechanism in motion is information acquisition by the voter, which depends on the marginal utility of public goods. When tax revenue increases, private consumption mechanically decreases. Although public good provision also increases due to the mechanical revenue effect, assumption 3 ensures that the marginal utility of the public good increases as well, which raises the benefit the voter gets from additional incumbent effort.[36] External revenue, on the other hand, has a negative effect on the marginal utility of the public good due to the positive mechanical revenue effect and the fact that it does not affect the voter's disposable income. Hence, extra taxation provides an incentive for more information acquisition while the opposite holds true for external revenue. The following proposition formalizes this result:

[36] Assumption 3 implies that taxation for the purpose of public good provision is inefficient in a setting where overhead costs are relatively large. This is consistent with the findings of Pritchett and Aiyar (2014), who report that the median cost of one pupil in public elementary school in India is twice as high as in a private school, but educational achievement is much lower.

Proposition 2. *Under Assumptions 2-4, the equilibrium first-period effort of the voter and the incumbent are increasing in tax revenue and decreasing in external revenue. Hence, public good provision in the first period increases by more than the mechanical revenue effect when there is an increase in tax revenue and by less than the mechanical revenue effect when there is an increase in external revenue.*

Proof. Using the implicit function theorem we can differentiate both sides of (10) with respect to $\tau\eta y$ to obtain:

$$\alpha\lambda\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}U''(\cdot)\left((\alpha\mu-1)+\alpha\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}\lambda\frac{\partial f_1^\star}{\partial\tau\eta y}\right)=K''(f_1^\star)\frac{\partial f_1^\star}{\partial\tau\eta y}$$

$$\Rightarrow \alpha\lambda\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}U''(\cdot)(\alpha\mu-1)=\frac{\partial f_1^\star}{\partial\tau\eta y}\left(K''(f_1^\star)-\alpha^2\lambda^2\left(\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}\right)^2U''(\cdot)\right) \tag{11}$$

Since $U(\cdot)$ is a strictly concave function while $K(f_1)$ is strictly convex, the LHS in equation 11 is positive and the term in brackets on the right is also positive. Hence, $\partial f_1^\star/\partial\tau\eta y > 0$. This implies, from equation 1, that the overall effect of an increase in tax revenue on public good provision is given by

$$\frac{\partial g_1^\star}{\partial\tau\eta y}=\mu+\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}\lambda\frac{\partial f_1^\star}{\partial\tau\eta y}>\mu$$

Using implicit differentiation on equation 10 but with respect to exogenous revenue (T) yields:

$$\alpha\lambda\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}U''(\cdot)\alpha\mu=\frac{\partial f_1^\star}{\partial T}\left(K''(f_1^\star)-\alpha^2\lambda^2\left(\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}\right)^2U''(\cdot)\right) \tag{12}$$

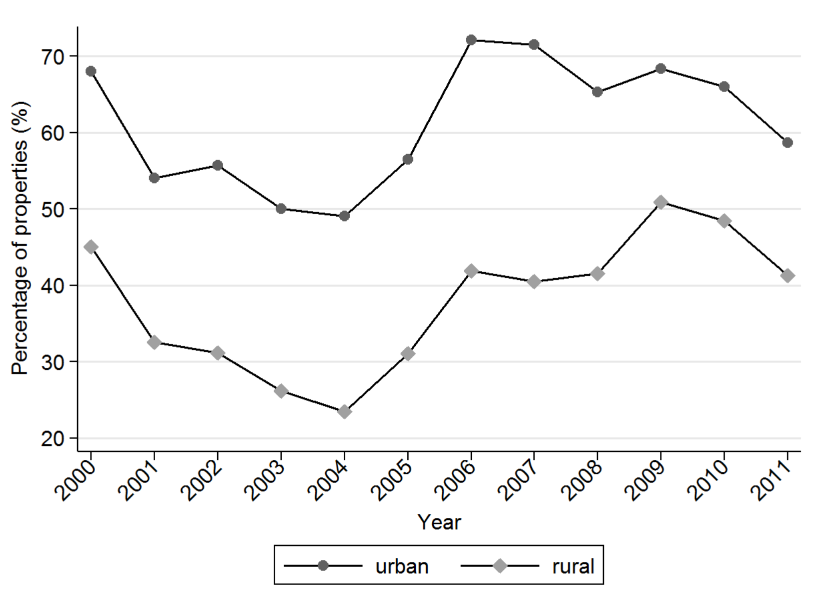
Now the LHS in equation 12 is negative, while the term in brackets on the right remains positive. Hence, $\partial f_1^\star/\partial T < 0$. Using again equation 5, we can see that the net effect of an increase in exogenous revenue on first-period public good provision is

$$\frac{\partial g_1^\star}{\partial T}=\mu+\frac{\partial e_1^\star}{\partial h_Z}\frac{\partial h_Z}{\partial h_R^\epsilon}\lambda\frac{\partial f_1^\star}{\partial T}<\mu<\frac{\partial g_1^\star}{\partial\tau\eta y}$$

□

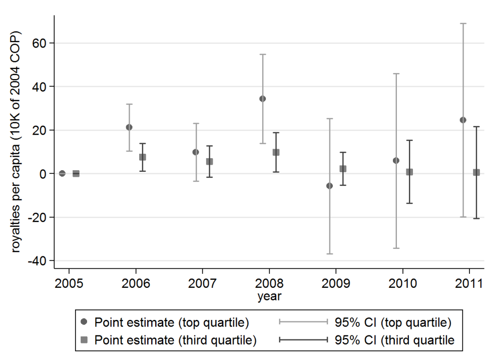
Appendix B   Empirical Appendix

Figure A1: Percentage of properties with up-to-date cadastres

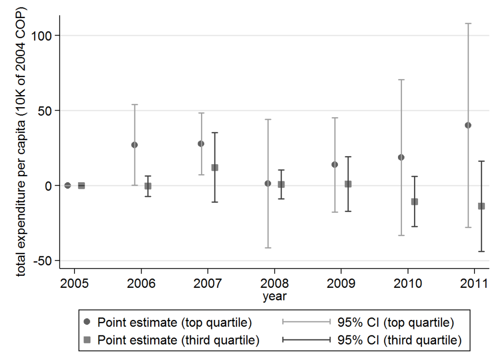


Note: The figure shows the percentage of properties in the sample located in urban/rural areas of municipalities that had a cadastral update in the last five years (up to date). The sample does not include Bogota, Cali, Medellín and the department of Antioquia, which have their own cadastral agencies.

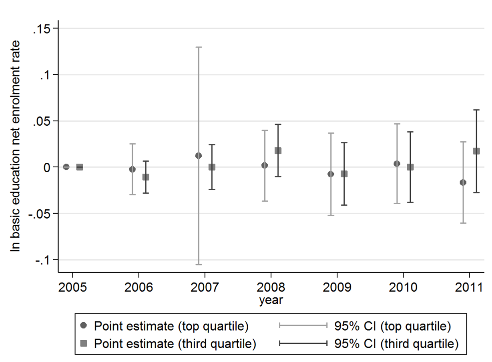
Figure A2: Medium-run impact of oil price shocks for the top two quartiles of oil abundance



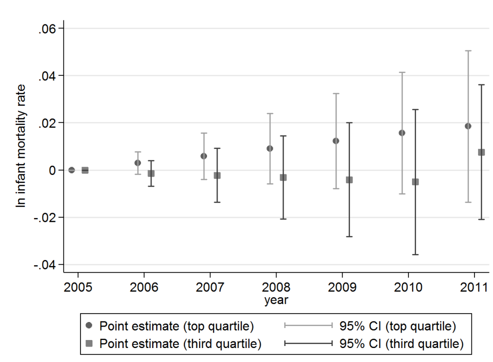
(a) Royalties



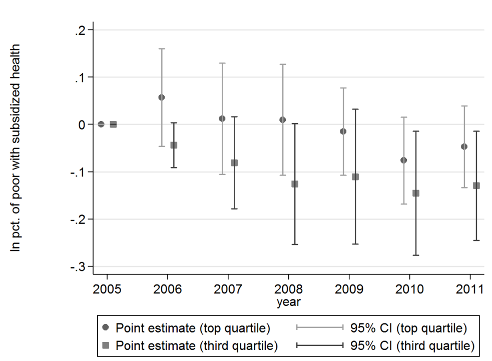
(b) Expenditure



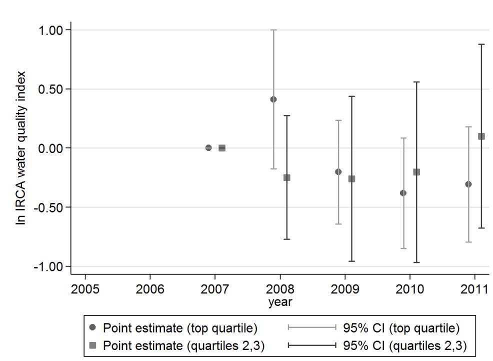
(c) Educational enrolment



(d) Infant mortality



(e) Health insurance



(f) Water quality

Note: Each graph shows point estimates and 95 % confidence intervals from two separate regressions of the variable in the caption on a set of year interactions (2006-2011) with a dummy for municipalities with positive oil royalties between 2000 and 2004. These regressions use data from the period 2005-2011. The sample includes municipalities with no oil royalties or municipalities in the relevant quartile of the oil royalties 2000-2004 distribution. All regressions include municipality and department-year fixed effects. Standard errors are clustered by province.

Table A1: Social indicators in Colombia and other Latin American countries

COUNTRY	(1) GDP per capita (USD)	(2) Primary enrolment rate (%)	(3) Secondary enrolment rate (%)	(4) Infant mortality rate (‰)	(5) Female life expectancy (years)	(6) Improved water source (%)	(7) Improved sanitation facilities (%)
Argentina	4,696	99	-	16	78	98	94
Bolivia	978	92	72	46	67	94	53
Brazil	3,598	-	-	22	75	98	84
Chile	6,324	-	-	8	81	99	97
Colombia	**2,740**	**92**	**63**	**19**	**76**	**97**	**84**
Ecuador	2,709	97	51	25	77	89	82
Mexico	7,115	95	63	17	78	95	84
Panama	4,349	97	61	20	79	98	80
Paraguay	1,409	94	57	25	73	94	87
Peru	2,445	97	68	23	75	90	77
Uruguay	4,117	97	-	13	79	99	95
Venezuela	4,273	92	61	16	76	94	94

Notes: GDP per capita in current USD. Percentages of improved water source and improved sanitation facilities refer to urban population. Data from 2004 (2003 or 2005 if 2004 unavailable). Source: World Development Indicators (World Bank).

Table A2: Cadastral updates and statutory tax rates

VARIABLES	(1) Property tax rate	(2)	(3) ln Property tax rate	(4)
D(post-cadastral-update)$_{i,t}$	0.0964	0.176	0.0103	0.0185
	[0.151]	[0.160]	[0.0201]	[0.0203]
Time fixed effects	year	dpt-year	year	dpt-year
Observations	799	799	799	799
Number of municipalities	211	211	211	211

Dependent variable in the header. All regressions include municipality fixed effects. Columns 1 and 3 include year fixed effects while columns 2 and 4 include department-specific year fixed effects. Sample period: 1999-2002. Average tax rate is 8.4 ‰. Standard errors clustered two-way by municipality and by department-year. *** p<0.01, ** p<0.05, * p<0.1

Table A3: Sources of revenue and public good provision (cumulative royalties)

	natural log [columns 1-4]				D(target achievement) [columns 5-8]			
VARIABLES	(1) Educational enrolment	(2) Infant mortality	(3) Health insurance	(4) Water quality	(5) Educational enrolment	(6) Infant mortality	(7) Health insurance	(8) Water quality
PANEL A: REDUCED FORM								
D(post-cadastral-update)$_{i,t}$	0.00886***	0.00302	0.0127	0.121**	0.0133	-0.000528	0.0318*	0.0769***
	[0.00333]	[0.00210]	[0.00856]	[0.0559]	[0.0133]	[0.0109]	[0.0174]	[0.0219]
$\sum_{k=2006}^{t}$ royalties$^{\text{oil}}_{i,00-04}$ $\times$ price$^{\text{oil}}_{k}$	-5.25e-06	-1.49e-05	-0.000112**	-0.000833	-6.13e-05	-8.39e-06	-1.39e-05	-0.000466
	[1.84e-05]	[1.33e-05]	[4.89e-05]	[0.000580]	[0.000180]	[2.57e-05]	[0.000183]	[0.000305]
PANEL B: IV								
property tax revenue$_{i,t}$	0.0142**	0.00483	0.0203	0.145*	0.0213	-0.000851	0.00508*	0.0918***
	[0.00619]	[0.00359]	[0.0138]	[0.0772]	[0.0209]	[0.0174]	[0.0288]	[0.0283]
natural resource royalties (cum.)$_{i,t}$	-2.06e-05	-2.33e-05	-0.000159***	-0.00130**	-9.72e-05	-9.57e-06	-6.77e-05	-0.000751**
	[2.39e-05]	[1.65e-05]	[6.12e-05]	[0.000659]	[0.000224]	[3.65e-05]	[0.000226]	[0.000310]
1st stage F-statistic	11.807	11.807	11.807	7.381	11.807	11.807	11.807	7.381
p-value H0:tax=royalties	0.022	0.176	0.139	0.059	0.306	0.962	0.077	0.0001
Dependent variable mean in 2005 (level)	86.1	24.2	74.3	30.5	0.15	0.16	0.15	0.18
Observations	6,704	6,704	6,704	4,467	6,704	6,704	6,704	4,467
Number of municipalities	969	969	969	937	969	969	969	937

Dependent variable in the header: in columns 1-4 the dependent variable is in natural log, while in columns 5-8 it is a dummy for target achievement. Money variables in tens of thousands of 2004 COP per capita. In panel B, D(post-cadastral-update) and $\sum_{k=2006}^{t}$ royalties$^{\text{oil}}_{i,00-04}$ $\times$ price$^{\text{oil}}_{k}$ are used as instruments for property tax revenue and cumulative natural resource royalties, respectively. All regressions include municipality-term and department-year fixed effects (sample period: 2005-2011, except column 4: 2007-2011). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table A4: Sources of revenue and public good provision with municipality-term FE

	natural log [columns 1-4]				D(target achievement) [columns 5-8]			
VARIABLES	(1) Educational enrolment	(2) Infant mortality	(3) Health insurance	(4) Water quality	(5) Educational enrolment	(6) Infant mortality	(7) Health insurance	(8) Water quality
PANEL A: REDUCED FORM								
D(post-cadastral-update)$_{i,t}$	0.00506*	0.00186*	0.00749	-0.0403	0.00820	0.000218	0.00366	0.0686**
	[0.00285]	[0.00105]	[0.00823]	[0.0779]	[0.0139]	[0.0106]	[0.0179]	[0.0295]
royalties$^{oil}_{i,00-04}$ × price$^{oil}_{t}$	0.00233	0.000343	-0.00845	-0.242*	0.0281	0.00161	-0.0390	0.0615
	[0.00167]	[0.000869]	[0.0161]	[0.134]	[0.0181]	[0.00243]	[0.0334]	[0.0752]
PANEL B: IV								
property tax revenue$_{i,t}$	0.00771*	0.00282	0.0112	-0.0491	0.0130	0.000363	0.00476	0.0731**
	[0.00448]	[0.00188]	[0.0119]	[0.0870]	[0.0207]	[0.0161]	[0.0274]	[0.0344]
natural resource royalties$_{i,t}$	0.000176*	3.66e-05	-0.000389	-0.0108	0.00161	9.01e-05	-0.00209	0.00314
	[0.000103]	[4.66e-05]	[0.000846]	[0.00842]	[0.00110]	[0.000193]	[0.00207]	[0.00385]
1st stage F-statistic	9.424	9.424	9.424	4.968	9.424	9.424	9.424	4.968
p-value H0:tax=royalties	0.090	0.135	0.334	0.656	0.577	0.986	0.801	0.041
Observations	6,698	6,698	6,698	3,609	6,698	6,698	6,698	3,609
Number of municipality-term FE	1,931	1,931	1,931	936	1,931	1,931	1,931	936

Dependent variable in the header: in columns 1-4 the dependent variable is in natural log, while in columns 5-8 it is a dummy for target achievement. Money variables in tens of thousands of 2004 COP per capita. Standardized coefficients for royalties$^{oil}_{i,00-04}$ × price$^{oil}_{t}$. In panel B, D(post-cadastral-update) and royalties$^{oil}_{i,00-04}$ × price$^{oil}_{t}$ are used as instruments for property tax revenue and natural resource royalties, respectively. All regressions include municipality-term and department-year fixed effects (sample period: 2005-2011, except column 4: 2007-2011). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table A5: The effects of oil price shocks on municipalities in the top quartiles of the oil abundance distribution

VARIABLES	(1) Royalties	(2) ln population	(3) Business tax	(4) Murder rate	(5) FARC events	(6) Educational enrolment	(7) Infant mortality	(8) Health insurance	(9) Water contamination
PANEL A: third quartile - contemporary royalties									
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_t$	2.082*	-0.000401	0.243	-2.685	0.150	0.00447***	0.000951	-0.00402	0.0504
	[1.165]	[0.00110]	[0.202]	[1.881]	[0.201]	[0.00171]	[0.00147]	[0.00868]	[0.0705]
Observations	6,704	5,990	5,990	5,990	5,131	5,990	5,990	5,990	3,970
Number of municipalities	969	865	865	865	862	865	865	865	833
PANEL B: top quartile - contemporary royalties									
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_t$	0.868***	-2.77e-07	0.0227	-0.114	0.0416***	0.000161	-1.63e-05	-0.000836	0.0112
	[0.184]	[2.69e-05]	[0.0281]	[0.0953]	[0.0155]	[0.000115]	[2.90e-05]	[0.000704]	[0.00731]
Observations	5,975	5,975	5,975	5,975	5,116	5,975	5,975	5,975	3,957
Number of municipalities	862	862	862	862	859	862	862	862	830
PANEL C: third quartile - cumulative royalties									
$\sum_{k=2006}^{t} \text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_k$	1.448***	0.000421*	0.0164	-0.0536	-0.0161	0.000274	6.46e-05	-0.00257*	0.00208
	[0.517]	[0.000231]	[0.0306]	[0.242]	[0.0324]	[0.000448]	[0.000277]	[0.00144]	[0.00945]
Observations	5,990	5,990	5,990	5,990	5,131	5,990	5,990	5,990	3,970
Number of municipalities	865	865	865	865	862	865	865	865	833
PANEL D: top quartile - cumulative royalties									
$\sum_{k=2006}^{t} \text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_k$	0.802***	5.56e-05***	0.0104***	-0.0108	0.00201	1.00e-05	-6.82e-05	-0.000121***	-0.000977
	[0.0556]	[1.36e-05]	[0.00214]	[0.0167]	[0.00148]	[1.8e-05]	[1.76e-05]	[4.42e-05]	[0.000676]
Observations	5,975	5,975	5,975	5,975	5,116	5,975	5,975	5,975	3,957
Number of municipalities	862	862	862	862	859	862	862	862	830

Notes: Dependent variable in the header (natural log in columns 6-9). Sample in panels A and C (B and D) only includes municipalities with zero oil royalties between 2000 and 2004 and municipalities in the third (top) quartile of the distribution of positive average 2000-2004 royalties. All regressions include municipality and department-year fixed effects. Standard errors clustered two-way by municipality and department-year. Sample period: 2005-2011, except columns 5 (2005-2010) and 9 (2007-2011). *** p<0.01, ** p<0.05, * p<0.1

Table A6: Heterogeneous effects of oil-price shocks by FARC activity

VARIABLES	(1) Royalties	(2) Educational enrolment	(3) Infant mortality	(4) Health insurance	(5) Water quality
PANEL A: NATURAL LOG					
D(post-cadastral-update)$_{i,t}$	-0.266	0.00884***	0.00300	0.0116	0.124**
	[0.896]	[0.00335]	[0.00206]	[0.00847]	[0.0561]
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t}$	0.831***	0.000164	8.12e-06	-0.000458	0.0117*
	[0.173]	[9.10e-05]	[7.72e-06]	[0.000738]	[0.00657]
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t} \times \text{FARC events}_{i,05-10}$	0.0568	-0.000133**	3.14e-05	0.000111	-0.00149***
	[0.0939]	[6.74e-05]	[2.49e-05]	[0.000117]	[9.12e-05]
PANEL B: D(TARGET ACHIEVEMENT)					
D(post-cadastral-update)$_{i,t}$		0.0134	-0.00123	0.0324*	0.0762***
		[0.0134]	[0.0109]	[0.0173]	[0.0219]
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t}$		0.00143**	6.19e-05	-0.00177	0.00290
		[0.000715]	[6.22e-05]	[0.00143]	[0.00365]
$\text{royalties}^{\text{oil}}_{i,00-04} \times \text{price}^{\text{oil}}_{t} \times \text{FARC events}_{i,05-10}$		-0.000197	2.62e-05	-1.28e-05	-0.000398
		[0.000329]	[4.25e-05]	[0.000611]	[0.000291]
Observations	6,684	6,684	6,684	6,684	4,453
Number of municipalities	966	966	966	966	934

Dependent variable in the header. In panel A, the dependent variable is in natural log, while in panel B it is a dummy for target achievement. Money variables in tens of thousands of 2004 COP per capita. All regressions include municipality-term and department-year fixed effects (sample period: 2005-2011, except column 4: 2007-2011). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table A7: Sources of revenue and public good provision (Coal royalties)

	natural log [columns 1-4]				D(target achievement) [columns 5-8]			
VARIABLES	(1) Educational enrolment	(2) Infant mortality	(3) Health insurance	(4) Water quality	(5) Educational enrolment	(6) Infant mortality	(7) Health insurance	(8) Water quality
PANEL A: REDUCED FORM								
D(post-cadastral-update)$_{i,t}$	0.00884***	0.00297	0.0121	0.118**	0.0131	-0.000671	0.0316*	0.0747***
	[0.00334]	[0.00210]	[0.00852]	[0.0562]	[0.0134]	[0.0109]	[0.0173]	[0.0221]
royalties$^{coal}_{i,2004}$ × price$^{coal}_{t}$	0.000983	0.00352	0.00139	0.0437	0.00781	-0.0109	-0.0135	0.00376
	[0.00383]	[0.00246]	[0.00317]	[0.0391]	[0.0153]	[0.00725]	[0.0290]	[0.00709]
PANEL B: IV								
property tax revenue$_{i,t}$	0.0141**	0.00491	0.0193	0.140*	0.0212	-0.00166	0.0494*	0.0874***
	[0.00612]	[0.00355]	[0.0137]	[0.0757]	[0.0206]	[0.0173]	[0.0285]	[0.0276]
natural resource royalties$_{i,t}$	5.72e-05	0.000313	8.26e-05	0.00360	0.000669	-0.000996	-0.00136	-0.000186
	[0.000341]	[0.000215]	[0.000287]	[0.00350]	[0.00142]	[0.000748]	[0.00282]	[0.000855]
1st stage F-statistic	11.240	11.240	11.240	2.901	11.240	11.240	11.240	2.901
p-value H0:tax=royalties	0.022	0.195	0.160	0.074	0.325	0.969	0.075	0.002
Observations	6,704	6,704	6,704	4,467	6,704	6,704	6,704	4,467
Number of municipalities	969	969	969	937	969	969	969	937

Dependent variable in the header: in columns 1-4 the dependent variable is in natural log, while in columns 5-8 it is a dummy for target achievement. Money variables in tens of thousands of 2004 COP per capita. In panel B, D(post-cadastral-update) and royalties$^{coal}_{i,2004}$ × price$^{coal}_{t}$ are used as instruments for property tax revenue and natural resource royalties, respectively. All regressions include municipality-term and department-year fixed effects (sample period: 2005-2011, except column 4: 2007-2011). Standard errors clustered two-way by municipality and department-year. *** p<0.01, ** p<0.05, * p<0.1

Table A8: Sample disciplinary processes involving mayors of municipalities with oil royalties

(1) Municipality	(2) Period	(3) Mayor's name	(4) Findings	(5) Ban from office (years)
Arauquita, Arauca	2001-2003	Jorge Aperador	Signed two contracts with the same firm for the same multi-purpose sports court	18
Puerto Boyaca, Boyaca	2004-2007	Luis Alvarez	The firm hired to build a public library sub-contracted for 1/3 of the original value	15
Coloso, Sucre	2004-2007	Manuel Ruiz	Bypassed selection process for sewerage construction by declaring an unwarranted "state of urgency"	11
Villavicencio, Meta	2004-2007	Carlos Gómez	Unauthorized expenditures at local hotel were later deducted from tax liabilities	11
Tolu, Sucre	2004-2007	Liceloth Luquez	Falsely divorced from current mayor to be able to succeed him in office	10
Gigante, Huila	2008-2011	Julian Diaz	Built a road through his parents' and uncles' properties	10
Melgar, Tolima	2008-2011	Eduardo Tautiva	Allowed a mayoral candidate to inaugurate two schools	15
Cantagallo, Bolivar	2008-2011	Ramiro Escobar	Used royalties to buy furniture for city hall	15
Arauca, Arauca	2008-2011	William Reyes	Purchase of bonds through irregular firm led to 50 % loss on royalties (5 million USD)	20
Yopal, Casanare	2012-2015	Willman Celemin	Bought 157 spa sessions for members of staff	11

Notes: The table shows 10 cases in which the mayor of a municipality with positive oil royalties in the 2000-2004 period was removed from office between 2001 and 2015. There are 64 such processes in the sample. Source: News bulletins in PGN website.

Table A9: Keywords from disciplinary processes of mayors of municipalities with oil royalties

Panel A: Misconduct	Percentage of cases (%)	Panel B: Sector	Percentage of cases (%)
Asset Management	6.9	Royalties	12.0
Investment/Procurement	36.4	Education	8.3
General Administration	24.0	Health	3.2
Hirings/Appointments	9.2	Utilities	15.2
Payments/Obligations	17.5	Elections	6.4

Notes: The tables show the percentage of the disciplinary processes initiated by PGN, involving mayors of municipalities with positive oil royalties in the period 2000-2004, that include each keyword. Panel A shows keywords for the type of offence, while panel B shows keywords for the sector. Source: News bulletins in PGN website.