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Abstract

We study the role of natural resource windfalls in explaining the efficiency of public expenditures. Using a rich dataset of expenditures and public good provision for 1,836 municipalities in Peru for period 2001-2010, we estimate a non-monotonic relationship between the efficiency of public good provision and the level of natural resource transfers. Local governments that were extremely favored by the boom of mineral prices were more efficient in using fiscal windfalls whereas those benefited with modest transfers were more inefficient. These results can be explained by the increase in political competition associated with the boom. However, the fact that increases in efficiency were related to reductions in public good provision casts doubts about the beneficial effects of political competition in promoting efficiency.

Keywords: Resource booms, intergovernmental transfers, local government efficiency.

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1. Introduction

The recent boom of natural resources in developing countries have renewed the interest of international media, policy-makers and scholars in old questions regarding the role of natural resources in economic development. Whereas the abundance of natural resources has been usually linked to poor economic and political performance (Sachs and Warner 1995, Karl 1997 and Ross 1999, among others), the empirical evidence in this regard is largely inconclusive.

This is particularly acute for the case of the fiscal consequences of resource booms. The dramatic increase of the international prices of oil, minerals and some agricultural products has been associated to an important expansion of fiscal resources in resource-rich countries which has created an extraordinary opportunity to improve peoples' living conditions. This is also true for the case of subnational governments, which have experienced large increases in their budgets as a consequence of the implementation of legal frameworks that grant them access to an important fraction of these fiscal resources in many countries around the world[1].

Whether subnational governments are using these fiscal resources in an efficient manner has become a critical issue in many countries in which these allocation rules are in place, yet very little is known about how these systems work in practice and how they may affect the behavior of subnational politicians. Media has particularly highlighted the cases of perverse behaviors committed by political authorities, in which these authorities are portrayed as inefficient and corrupt, but we lack of systematic evidence on this regard[2].

In this paper, we study the Peruvian experience to shed light on these issues exploiting subnational variation in natural resource rents induced by a set of rules about the allocation of a fraction of the taxes paid by mining companies to the districts where mineral resources were extracted. These rules are known as "mining Canon"[3] in the country. We are particularly interested in the role of natural resource rents in explaining the levels of efficiency of local governments in Peru, paying attention to the way in which these rents can distort the behavior of local politicians.

[1] For instance, Indonesia, Ghana, Colombia, Brazil, Bolivia, Canada, Australia, just to mention few countries, have implemented mechanisms that share part of taxes and royalties paid by extractive companies with subnational governments. See Brosio and Jimenez (sf) for an overview.
[2] See, for instance, Caselli and Micheals (2013) and Monteiro and Ferraz (2012) for evidence for Brazil. Hunt (2007) and Maldonado (2011) offers evidence on corruption of public officials from Peru.
[3] Originally, "Canon" is a Spanish word used in the country to refer a tax related to a specific activity. The current use refers to a rule by which a fraction of the revenues collected by the central government is allocated to sub-national governments.

This issue has recently attracted a lot of interest among scholars (Ardanaz 2012) since anecdotal and previous empirical evidence has shown that the fiscal expansions related to resource booms have not been accompanied by increases in public good provision and improvement in citizens' well-being (Caselli and Micheals 2013, and Ferraz and Monteiro 2012)[4], suggesting that these fiscal resources are being wasted.

To understand the link between natural resource rents and local government efficiency, we suggest studying the behavior of local politicians. Following some recent scholarship (Caselli 2006, Maldonado 2014), we believe that this relationship is non-monotonic. The basic idea is that resource booms are related to an increase in political competition due to an increase in the value of holding office. On the other hand, there is also to incumbent advantage since mayors have more fiscal resources to influence electoral outcomes. In a simple economy in which production of a commodity depends on a public good (like roads), the incumbent politician can prevent entry of a potential competitor by increasing the provision of this public good, increasing in this way the opportunity cost of becoming politician. The optimal response of the potential competitor would be to produce this commodity rather than becoming a politician. However, for higher values of natural resource rents, the value of holding office would be higher than the profits of commodity production, in which case the agent's optimal response would be to run for election against the incumbent politician. Since the probability of reelection is lower with the competitor's entry, the optimal response of the incumbent politician would be to increase his political rents and to reduce the provision of public goods. As consequence, a non-monotonic relationship between natural resource rents and public good provision is expected.

We relate this non-monotonic pattern to the efficiency of public expenditures. An increase in the levels of rents of small magnitude will have a limited impact in the value of holding office, being the incumbent able to prevent entry. As a consequence, limited political competition is observed, creating room for inefficient use of the local government budget since the mayor's position is not challenged but more fiscal resources are available. As the level of rents increases, the value of holding office increase as well, facing the incumbent more competition. However, since more rents are available, the incumbent has incentives to invest in more public goods to avoid

[4] This common view has been challenged for new studies that suggest that the effect of resource boom can be beneficial (Aragon and Ruud 2013) or that there is non-monotonic pattern in terms of public good provision (Maldonado 2014).

entry. As a consequence, an increase in efficiency is observed. However, when the change in natural resource rents is large, the value of holding office is higher than the expected profit in the industrial sector for the potential competitor, so the mayor cannot prevent entry and reduces public good provision. This reduction can still be consistent with higher levels of efficiency since this indicator only reflects a ratio between fiscal resources and public goods, and mayors invest less in both when they expect not to be reelected. Therefore, we expect a non-monotonic relationship between natural resource rents and efficiency of local governments' expenditures.

The Peruvian case offers and ideal scenario to explore the impact of resource booms on the efficiency of local governments. The country is one of the most important mineral producers of the world[5], being one country in which the recent resource boom has had dramatic consequences. Mineral production has been multiplied by more than 5 (from 1,350 to 7,050 US millions) and rents distributed to producer regions increased by 118-fold (from 7 to 827 US millions) from 1996 to 2010. This extraordinary increase in a very short-period have created few rich municipalities that have experienced a dramatic increase in their budgets creating an ideal scenario to study the impact of natural resource windfalls on local government efficiency. A final reason, it is the nature of the local political arena in the country, characterized by its high level of fragmentation and weekly connection with national political parties, making the Peruvian case less sensitive to strategic interactions between local politicians and national political parties that may affect the rules of mining rents distribution.

Using a difference in difference approach with a quadratic specification to account for the non-monotonicity implied by the conceptual framework, we find consistent evidence regarding the non-monotonic relationship between mining Canon rents and public expenditures. We first document a non-monotonic impact of mining Canon rents on different types of expenditures, particularly investment. Local governments with modest level of mining transfers show a positive net effect whereas those local governments with extremely high levels of these transfers this effect negative.

We then use a Free Disposal Hull approach to estimate the efficiency scores for a set of combination of expenditures and public goods in transport, infrastructure, health and education.

[5] Currently, Peru is the 2nd producer of copper and silver, the 3rd of zinc and tin, the 4th in lead and molybdenum, and 6th in gold. See Ministerio de Energia y Minas (2012) for details.

These scores are essentially the same when they are estimated with an alternative approach called Data Envelopment Analysis. In a second stage, we relate these scores to mining Canon rents to evaluate the levels of association between them in a cross-sectional Tobit regression. We also find a non-monotonic pattern. For a local government with average level of mining Canon rents, the effect is negative implying that in these municipalities mining Canon rents are negatively associated with efficiency. On the other hand, for richer mining rents recipients, the marginal effect is positive, suggesting that richer local governments are more efficient.

After finding consistent evidence with the theoretical framework, we explore the role of political competition as the main mediator factor between mining Canon rents and efficiency in local government expenditures. We find robust evidence of a non-monotonic relationship between mining Canon rents and political competition along the lines of Maldonado (2014). The marginal effect is negative for the average municipality (implying a reduction in political competition) but positive for richer municipalities (with the opposite effect on political competition). Although this increase in efficiency may appear positive at first sight, the reduction observed in public expenditures -as well as a reduction in the provision of public goods for richer municipalities- offer a somewhat more negative interpretation. Due to higher political competition, the increase in efficiency along a reduction in public good provision may reflect the strategic response of incumbent politicians to increase their rents since their political horizons have been reduced. It can be also consistent with a substitution towards alternative forms of redistribution (like clientelism) to influence electoral outcomes in a more competitive political environment.

Our results are robust to an ample set of budgetary, socio-economic and geographical controls. They are also robust to alternative ways to derive the efficiency scores and are also valid after relaxing the distributive assumptions of the second-stage Tobit model using a censored quantile regression approach. They are also robust to the type of public good analyzed.

This paper is related to a recent literature that explores the economic and political effects of natural resource booms. One strand of the literature has explored the impact of resource booms in the behavior of politicians with respect to electoral outcomes like reelection and political competition (Monteiro and Ferraz 2012, and Maldonado 2014). Other scholars have explored the impact of resource booms on citizens' well-being via public good provision (Caselli and Micheals 2013, Loayza et. al. 2013, and Maldonado 2014) and demand of local inputs (Aragon and Ruud 2013). Other dimensions explored by researchers include corruption (Brollo et al 2013, Maldonado

2011 and Vicente 2010), politician quality (Brollo et al 2013), conflict (Angrist and Klueger 2008, Arellano 2011, Dube and Vargas 2013) and citizens' confidence in political institutions and democracy (Maldonado 2012).

This paper also contributes to a large literature about the efficiency of local governments. Alfonso and Fernandes (2008) for Portugal; Balaguer-Coll et al (2007), Gimenez and Prior (2007) and Benito et al (2010) for Spain; Borge et al (2008) and Revelli (2007) for Norway; Da Conceicao and Stosic (2005) for Brazil; De Borger et al (1994) and De Borger and Kerstens (1996) for Belgium; Kalb et al (2012) for Germany; Geys et al (2009a and 2009b) for Flanders; Stevens (2005) for England; Worthington (2000) for Australia; and Herrera and Francke (2007) for Peru are some examples in the literature. More closely related to this paper is Ardanaz (2012), who studies the role of oil royalties in explaining the efficiency of local government expenditures for Brazilian municipalities.

The rest of the paper is organized as follows. Section 2 provides some basic details about the institutional setting. Section 3 introduces a basic theoretical framework whereas Section 4 describes the data. Section 5 presents the empirical methodology and section 6 presents the empirical results. Section 7 concludes the paper.

2. Institutional background[6]

Local Politics. Although local governments are an old institution in Peru, they were granted constitutional political autonomy for the first time in 1979. Currently, there are about 1645 local governments, 1840 if we include the provincial governments that also play the role of local governments in the provincial capitals (195 in total). According to the current legal framework, municipalities are governed by the major and a council, having the former a great discretionary power in municipal government decisions. Mayors are granted 50% plus 1 seats in the municipal council, no matter the share of votes. In practice, this has constrained the ability of local political parties from the opposition to exercise political accountability.

Due to the collapse of the national party system in the late 80s, national political parties play a minor role in local elections[7]. One of the consequences of the breakdown of the political party system is the lack of party loyalty, which is especially common among local politicians.

[6] This section follows Maldonado (2014).

[7] There is a large literature about the collapse of the party system in Peru in late 80s. See Tanaka (2002), Roberts (2006) and Seawright (2012) for an explanation of the origins and consequences of this collapse.

Many majors were re-elected under different political brands over the past years. As a consequence, local politics is highly personalistic.

Although electoral rules allow local politicians a high degree of freedom, the weak institutional capacity of local governments works as an important constraint for their political behavior. Most of the local governments in the country lack of stable and qualified public servants[8]. Not surprisingly, investment capacity is low.

According to the current legal framework, local governments' responsibilities can be classified in exclusive and shared. The first category includes urban and rural development, regulation and management of local public goods, local government organization, local development planning, and execution and monitoring of local public infrastructure (World Bank 2010:37). On the other hand, shared functions require coordination with other government levels (either provincial, regional or central government) and include participation in management of school services, public health, culture, sports and recreation, citizen security, transport, housing, and social programs and waste management. In practice, this overlap of functions has shown to be problematic since it has caused coordination problems among different levels of governments, affecting the performance of economic development and social programs.

Local public finance. Local governments are highly dependent from central government transfers since their ability to collect taxes is very limited. For instance, 97% of taxes are collected by the central government (Polastri and Rojas 2007). At the same time, transfers from central government represent 57% of local governments' budget. A significant part of transfers from central governments are allocated in the form of the Fondo de Compensacion Municipal (FONCOMUN) and the Glass of Milk program (56% and 10% of all intergovernmental transfers). These transfers are universally distributed among local governments[9]. The rest is allocated as targeted transfers. From these targeted transfers, Canon transfers (including all sources of Canon such as oil, hydropower, forest and gas Canon) represent a 91% of the total targeted transfers,

[8] Using the Registro Nacional de Municipalidades (RENAMU), Maldonado (2014) have estimated that only 21% of the local public servants have permanent contracts whereas 50% have temporary ones. More relevant is the fact that only 19% of local public servants have professional degrees. Aragon and Casas (2008) and Ponce and McClintock (2014) offer additional evidence about the role of limited state capacity for the case of local governments.

[9] The allocation of these transfers among districts follow distribution rules based on population size, infant mortality, illiteracy rates and poverty indicators based on basic needs. Those interested in the details, can consult MEF (2014).

being the mining Canon the most important one (79% of all Canon transfers). Therefore, mining Canon represents a significant fraction of local governments' budget in mineral-rich areas[10].

Mining legal framework. Mining is an activity with long tradition in Peru since colonial times. Historically, it has been associated to exploitation[11] and environmental degradation, which explains the negative perception that this activity has in areas where is performed. During the 90s, mining experienced a significant expansion because of a set of laws and regulations oriented to promote foreign direct investment in the sector as part of the market reforms introduced under the rule of Alberto Fujimori (1990-2001). As a consequence, mineral production grew at an average rate of 7.2% between 1992 and 2000 while the average GDP did so at a rate of 4.8%. This growth was mainly driven by the start of new large scale operations in copper, gold and silver production. Today, Peru is one of the most important producers of minerals in the world.

Along with the legal framework for promotion of mining activity, in 1992 the Central Government passed the first Mining Canon Law (DS 014-92 EM) which stated that a 20% of income tax should be allocated to the areas in which the profits were generated. In 2001, as part of the decentralization process, this law was modified to increase the participation of these areas. The most important law is the Law 27506 (known as the Canon Law),which states that the 50% of income tax paid by mining companies will be allocated to the regional and local governments located in the areas where the minerals are extracted. This amount is distributed between the regional government (20%), the municipality of the district (10%), the municipalities located in the province (25%), and the municipalities located in the region where the resource is exploited (40%). In addition, a 5% is allocated to the public universities of the region. This distribution rule has been changed several times in order to precise the criteria used to allocate the transfers among the local governments located in the same province and region of the mineral producer districts. Appendix 1 presents the legal framework related to mining Canon and other mineral resource-based rents.

Fiscal windfall and the boom of mineral resources. Since early 90's, the production of mineral resources experienced a significant increase as a consequence of the policies implemented to attract foreign investment in the mining sector. Figure 1 presents the evolution of the real value

[10] For period 2001-2010, Canon transfers represented 31% of total budgets in mineral producer districts.
[11] The best example of this is the mining Mita, a labor-forced system implemented by the Spanish Crown during colonial times.

of mineral production for period 1996-2010. After 2000, mineral production experienced an extraordinary increase of about 200%. It is interesting to note that the most important variation occurred before the increase in prices of natural resources in 2003, which suggests that most of the observed variation should be a consequence of the new regulatory framework in the mining sector implemented during the market reforms based on the Washington Consensus.

Although the increase in production played an important role in the recent mineral boom, more relevant was the increase of mineral prices. Figure 2 presents the evolution of the international prices of the four most important mineral resources produced by the country (copper, gold, silver and zinc) during the period of reference. As shown in the graph, these prices were quite stable from 1995 to 2003 and then underwent an extraordinary rise until 2010. In almost all the cases the prices were multiplied by two or three times in relation to the average prices before 2003.

As a consequence of the combined increase in prices and quantities, mining Canon transfers experienced an extraordinary increase. This was also accompanied by a change in the rule of allocation of mining Canon transfers that increased the participation of regional and local governments from the areas where mineral resources are extracted from 20% to 50%. Figure 3 describes that evolution. The amount of transfers due to royalties and mining Canon were relatively low (roughly 67 and 95 million of nuevos soles) during 2001 and 2002, having a spectacular increase since then[12]. This windfall was particularly beneficial for mineral producer districts due to the allocation rule, creating a highly unequal distribution of rents across local governments. For instance, the Gini coefficient for the distribution of rents for the period is 0.8. This is a critical element since previous evidence for the Peruvian case suggests that the behavior of municipalities with extraordinary high levels of mining Canon transfers is different than the average Canon recipient[13].

These inequalities are also reflected geographically. Due to geological factors, there is significant spatial variation in mineral production which implies that different areas are affected by different prices and consequently they are benefited by the mining boom in different ways. This suggests that the effects of the mining boom should be heterogeneous. Map 1 shows the allocation

[12] For reference, the current exchange rate is 2.85 nuevos soles per US dollar.

[13] Maldonado (2014) finds strong evidence of non-monotonic relationship between mineral rents and political competition, reelection outcomes, public good provision, public employment, local government expenditures and living standard measures. These non-monotonic effects are mainly driving by extremely rich municipalities in terms of mining rents.

of mining Canon transfers for 2010, the final year for which we have data. We observe a clear pattern with concentration of Canon-rich districts in the south (Tacna, Moquegua and Cusco), center coast (Ancash) and north (Cajamarca). The jungle and the coast close to the frontier with Ecuador are the areas in which Canon-poor districts are located.

3. Theoretical framework

To understand the relationship between local government efficiency and natural resource rents it is critical to model the behavior of local politicians and political elites in the face of a resource boom. Based on recent theoretical scholarship, we suggest that this relationship might be non-monotonic. For instance, Caselli and Cunningham (2009) explore an ample set of mechanisms for explaining the so-called political resource curse based on the behavior of the elite (or, "centralized mechanisms" using the terms proposed by the authors). In their models, an increase in natural resource rents raises the value of staying in power but also political competition. Due to the first mechanism, the elite allocates more time and resources to keeping power affecting its effort on productive activities and inducing negative spillovers on the private sector. These resources can be allocated either to boost citizens' welfare (creating a blessing) or to repress them. In the second mechanism, the increase of rents makes challengers more aggressive which in turn reduces the leader's time horizon, lowering the incentives for developing the non-resource sector leading to a resource curse. However, the leader can also react by increasing productive investment and increasing the value of the outside option of the challengers in which case the final result would be a blessing. Whether the final outcome is a curse or a blessing would depend on which mechanisms dominate.

The basic take-away of Caselli and Cunningham (2009) is the existence of potential non-monotonic responses in the presence of a resource boom. The logic is that resource booms attracts more competitors (political competition effect) but at the same time provides more fiscal resources that incumbents can use in order to keep power (incumbency advantage effect). Which effect dominates is going to depend on the magnitude of the boom. This basic intuition is exploited in Maldonado (2014), who adapts this basic model to analyze electoral competition in the presence of exogenous natural resource rents. In a simple two-period model, an incumbent politician decides the present value of his consumption by allocating the local government budget between political rents and public goods. He faces the potential competition of entrepreneurs, each of whom has to decide whether to work in the industrial sector or to become a challenger for the incumbent. He also faces competition of other local politicians that are active in the political market.

The provision of public goods is critical in this setting given that they are key inputs for production. When there is a resource boom of a modest magnitude, the incumbency advantage effect is going to dominate over the political competition one. The incumbent can reduce political competition by providing more public goods to citizens, making the opportunity cost of being or becoming a political challenger high. For those already in the political market, the increase in public good provision increases the opportunity cost of being politicians because of the new economic opportunities associated with the expansion of the stock of public goods. As a consequence, some of them will leave the political market to become entrepreneurs, reducing in this way the levels of political competition. Along the same lines, those who are not yet politicians will stay out of the political market.

As natural resource rents increase, the difference between both effects reduces and eventually there will be a threshold after which the political competition one would dominate over the incumbency advantage. The logic for this result is the following: when the boom is large in magnitude, the value of holding office is higher than the potential profits entrepreneurs can make in the industrial/service sector. As a consequence, some of them will be select themselves into politics, increasing political competition. Those already in politics would stay in the political market for similar reasons. Since public good provision cannot prevent political competition, the incumbent’s optimal response is to reduce the provision of public goods and to increase his political rents.

A natural extension of this framework is to link the effects on political competition with the incentives local politicians face in order to use efficiently local government budgets. When the increase of natural resource rents is modest, local politicians do not face significant political competition. In fact, some competitors will leave the political market to take advantage of the economic opportunities related to the expansion of the stock of public goods. This reduction is competition creates room to manage local government budget in an inefficient manner since the incumbent’s position is not challenged but more fiscal resources are available. Of course, this inefficiency drops as the level of rents increases since the incumbent react by providing more public goods when political competition is higher. In this case, the incentives for local politicians to manage public budgets more efficiently are higher.

Therefore, we expect a non-monotonic relationship between the size of natural resource rents and the efficiency of local government expenditures. Below certain threshold, the relationship is negative since the levels of rents are not high enough for the value of holding office to dominate over the incumbent's use of natural resource to prevent entry. Since the political horizon of the incumbent is not affected, he has room to manage the budget in an inefficient manner. After this threshold, this relationship is positive since more political competition creates incentives for the incumbent to use the budget is a more efficient manner since his political horizon is now reduced.

The relationship between political competition and local government efficiency suggested by this framework is consistent with alternative political economy models, although –to the best of our knowledge- this is the first paper that emphasizes a non-monotonic relationship[14]. Scholars from the Chicago School have always emphasized the efficiency of political competition (Stigler 1972 and Wittman 1989), but other scholars have suggested that high levels of political competition could lead to inefficient provision of public goods (Polo 1998 and Svensson 1998). The idea is that more political competition can create political instability, increasing the incentives to seeking for rents, which is consistent with Caselli (2006) and Caselli and Cunningham (2009) and several other models in political economy (for instance, Acemoglu and Robison 2006, and Lizzeri and Persico 2005). Recent theoretical and empirical contributions seem to suggest that the welfare-improving effects of political competition seem to be more relevant (Besley et al 2010 and Ashworth et al 2014), but -as Besley et al (2010) argues- there is no a general theoretical presumption that this will be always the case.

Our theoretical framework suggests that both approaches can be accommodated. The model predicts that more political competition increases efficiency but at the same time it reduces public good provision. Whereas most scholars in the efficiency literature seem to believe that more efficiency is related to more public good provision (Asworth et al 2014), there is no reason to believe that this should be always the case. At the end of the day, an efficiency indicator measures the maximum level of output for a given level of inputs. So, it is perfectly possible to observe a reduction in public good provision consistent with an increase in efficiency.

We test the empirical implications of this theoretical framework in the following sections.

[14] Besley et al (2010) also has a model that includes the possibility of non-monotonic effects but their outcomes of interest are not related to efficiency.

4. Data

4.1. Data Sources

We constructed a unique dataset from several data sources. A key element is the data on revenues and Canon transfers from the central government at district level over the period 1998-2010. This information was collected from the Ministry of Economy and Finance. It includes detailed information from all type of transfers received by local governments as well as information about other regular sources of incomes (taxes, contributions, fees for services, among others). Critically, it covers information about different type of expenditures that are critical inputs to develop the efficiency indicators.

The information about public goods was obtained from different sources. The most important one is the Registro Nacional de Municipalidades (RENAMU). This source is a census of municipalities carried out by the statistical agency yearly since 2001. The second source is the Census 2007. We constructed public good measures at district level.

We also collected information on mineral production and prices. It covers the period 1996-2010 and was collected from the Ministry of Energy and Mines. The data are available for each production unit. We aggregate the information to the district level for each producer districts over the period.

We also used electoral data for period 2002-2010 to evaluate the role of political factors in explaining local governments' efficiency. These data were collected from the National Office of Electoral Processes (ONPE). We construct an indicator of political competition based on the Herfindahl-Hirschman (HH) index of market competition adapted from Skilling and Zeckhouser (2002). This measure use vote shares to compute the complement of the HH index.

We use different sources to construct a set of control variables for the determinants of local governments' efficiency. From RENAMU, we created a set of geographical controls and socioeconomic characteristics for all the municipalities. Information for the period 2002-2010 is available for the analysis. We also took advantage of pre-boom data from the Census 1993.

4.2. Summary statistics

Table I presents basic summary statistics of the mining Canon transfers. We distinguish between three types of districts: producers, Canon recipients (excluding producers) and non-Canon recipients. On average, mineral producer districts received 475 nuevos soles per-capita during the period under analysis. This amount represents a 25% of the average monthly income per-capita in these areas. Canon recipient districts (excluding producers) receive 92 soles on average. These numbers do not take into account the extremes inequalities in the distribution of mining Canon transfers. For instance, whereas the percentile 90 of mineral producers gets 877 nuevos soles per-capita, the percentile 99 obtains 9,479 soles. This is evidence that, whereas a large number of districts receive this transfer, only few of them get it in large magnitudes.

Table I presents also descriptive statistics for a set of socio-economic characteristics for districts using Census 1993 data. The evidence suggests important differences among districts regarding population size, percentage of rural population and basic needs. This is expected since mineral production is performed in areas that have been historically exposed to poverty and exclusion, which is reflected in their basic needs indicators.

5. Empirical Methodology

The empirical methodology is composed of two elements. In the first place, we use a difference in difference (DD) model to study the impact of natural resource windfalls on local governments' budgets. The second element consists in the use of efficiency analysis to evaluate whether local governments in resource-rich regions are using the fiscal windfall in an efficient manner.

5.1. Testing the impact of resource windfalls on local governments' budget

The basic specification for the DD is as follows:

(1) $e_{it} = \alpha_i + \phi_t + \beta f(MC_{it}) + X'_{it}\delta + \varepsilon_{it}$

where e_{it} is the budget outcome of interest for district i in period t. α_i and ϕ_t are respectively district and years fixed effects. $f(MC_{it})$ is a measure of mining Canon transfers per-capita allocated to district i in period t. $X'_{it}\delta$ includes district level characteristics and ε_{it} is an error term. The parameter of interest is β which recovers the effect of interest. The time fixed-effects accounts for the time-series changes in our measures of fiscal revenues or expenditures. The district fixed-effects controls for time-invariant characteristics at district level and the MC_{jt} accounts for changes in dependent variable in treated districts associated to the movement of mining Canon revenues after the increase of prices of mineral resources. Identification in this setting requires controlling for any systematic shock to fiscal revenues or expenditures of the districts benefited by the increase of prices of mineral resources that are potentially correlated with, but not a consequence of, the revenues shock[15].

We specify $f(MC_{it})$ as a quadratic function. The reason of this methodological decision is based on the theoretical literature about the resource curse that suggests the existence of a strong non-monotonic pattern in the relationship between resource rents and economic and political outcomes[16].

We perform some corrections to standard inference procedures. We cluster standard errors at district level to control for within group dependence. As pointed out by Moulton (1986), inference without accounting for within-group dependence can severely underestimate standard errors. This also corrects for serial correlation common to DD models as highlighted by Bertrand, Duflo and Mullainathan (2004)[17].

5.2. Efficiency analysis

The efficiency analysis is based on techniques of frontier analysis. Typically, these techniques estimate the efficiency of a set of units by selecting the combination of input-output that reflect the most optimal use[18]. Then, those units whose combination of inputs-outputs deviates from this optimal combination are considered as "inefficient". Since Farell (1957), two types of efficiency are recognized: *technical inefficiency*, which is related to a situation in which a unit is using more inputs than technically required to produce a given output; and *allocative inefficiency*, which implies a sub-optimal use of inputs given current input prices and marginal productivities (Herrera and Pang 2005). Given the lack of information regarding input prices, we focus on technical efficiency in this paper.

Several approaches have been developed to estimate the efficiency frontier. The two basic ways to classify these approaches depend on whether the frontier is parametrically or non-

[15] Formally, this is known as the common trends assumption. In terms of counterfactuals, this implies an additive structure for the potential outcomes for the untreated districts. For a discussion, see Angrist and Pischke (2009), chapter 6.
[16] Maldonado (2014) follows this approach. He also shows that the parametric quadratic specification is robust compared to alternative non-parametric approaches.
[17] According to these authors, this is due to the following reasons: a) usually estimates are based long time series, b) the dependent variable is usually highly positively serially correlated, and c) the treatment variable changes very little within the treatment unit over time. In the context of this paper, a) is not a big issue since only 5 years are available. The other two issues will be controlled for in the empirical analysis.
[18] The modern literature on efficiency measurement dates back to Farell (1957). For a review of the literature with emphasis on local governments' performance, see Worthington and Dollery (2000).

parametrically estimated, or on whether the approach is stochastic or deterministic. We use a common non-parametric technique called Free Disposable Hull (FDH) developed by Deprins et al (1984), a variant of Data Envelope Analysis (DEA). In this approach, the frontier is constructed as a piecewise envelopment of the data using linear programming (Kalb et al 2012).

Technically, the FDH solves a linear programming problem of the following form (Geys et al 2009):

(2) $Min_{\{\lambda_k, z_1, z_2, ..., z_n\}} \ \lambda_k$

Subject to: (2.1) $\lambda_k C_k - \sum_{j=1}^{n} z_j C_j \geq 0$

(2.2) $\sum_{j=1}^{n} z_j y_{jr} \geq y_{kr}$ with $r = 1, ..., s.$

(2.3) $z_j \in \{0,1\}.$

C_k and C_j are respectively the total input for municipalities k and j. The output r for these municipalities is denoted as y_{kr} and y_{jr}. The number of outputs is represented by s and n is the number of districts. Finally, z_j are weights given to municipalities that are compared to municipality k in order to compute the efficiency score λ.

An advantage of this technique is that avoids the use of strong assumptions regarding the functional form of the relationship between inputs and outputs that are common in the deterministic frontier approach (DFA) and the stochastic frontier approach (SFA)[19]. Also, this technique keeps the assumptions regarding production technology to a minimum compared to DEA and the parametric approaches (in particular, it imposes free disposability of resources). In particular, DEA with variable returns to scale (DEA-vrs) assumes that the best-practice frontier is strictly convex. This assumption has been questioned on empirical grounds (Cherchye et al 2000).

[19] These two econometric approaches are used to estimating frontier production functions in which a theoretical production function represents an ideal against which empirical functions are evaluated to construct measures of inefficiency. When the difference between this ideal and the empirical observations for a set of units is associated solely to the inefficiency of the unit, we call this a *deterministic frontier function*. When this difference is related to inefficiency and a set of random factors such as luck or unexpected shocks, then we term this as a stochastic frontier production function. See Greene (2008) for an in-depth treatment of both approaches.

In any case, to recover DEA-vrs, it is enough to modify the condition in (2.3) by the following expressions:

$$(2.3') \ \sum_{j=1}^{n} z_j = 0.$$

$$(2.4) \ \lambda_k, z_j \geq 0 \ \text{for} \ j = 1, \ldots, n.$$

To the sake of completeness, the DEA approximation for the case of constant returns to scale (DEA-crs) is composed by equations (2), (2.1), (2.2) and (2.4). Since constant returns to scale imply that municipalities can linearly scale inputs and outputs without affecting efficiency (Geys et al 2009), it is considered that DEA-crs is too restrictive. We will not pursue this particular variant of DEA in the rest of the paper.

Despite the FDH advantages, there are also limitations associated to this technique. In particular, the quality of the data and the presence of outliers are critical. We control this issue by dropping the outliers before estimating the frontier. As a robustness analysis, we also estimate the frontier under a DEA approach. Results are qualitatively similar.

A critical concern for this approach is accounting for exogenous or non-discretionary variables. As pointed out by Stevens (2005), failing to account for these variables leads to an overstatement of the level of inefficiency. Two approaches have been proposed to deal with this issue. The first method consists in directly incorporate the exogenous variables into the computation of the efficiency scores using a parametric approach. Typically this implies imposing some additional structure in the error term associated to this model. The original inefficiency term of the standard parametric approach is further decomposed into a fraction explained by the non-discretionary variables and a residual inefficiency term[20].

The second approach is the so-called *two-stage approach*. In this approximation, the frontier is estimated without controlling for the exogenous factors. Then, a Tobit regression is implemented to assess the relationship between the estimated efficiency scores and the exogenous factors. The basic specification is the following:

$$(3) \ \hat{\lambda}_i = a + bf(MC_i) + Z_i^{'}\gamma + v_i \geq 1,$$

[20] See Kalb et al (2012) for a recent application of this approach.

where $\hat{\lambda}_i$ is the efficiency measure for district i estimated in the first step, $f(MC_{it})$ is a measure of mining Canon transfers per-capita for district i, and Z_i is a set of control variables. Given the cross-sectional nature of this part of the empirical analysis[21], we use different set of control variables in order to remove selection bias. Besides the traditional budget and socio-economic controls, we take advantage of the fact that mineral production critically depends on geographical dimensions to provide a causal interpretation for the reduced-form results by including altitude, longitude, latitude, and distance to province capital along a set of dummy variables to account for locational characteristics and region fixed effects. The identification assumption in our preferred specification is that -once budgetary, socio-economic and geographical dimensions have been accounted for- the differences in mining Canon transfers across municipalities in the same region is as good as random. Finally, as standard in this case of models, v_i is assumed to be normal with a zero mean and constant variance.

There is a debate in the literature regarding the benefits and shortcomings of both approaches. One advantage of the first approach is its ability to jointly provide a way to correct for the omission of exogenous factors and provides parameters estimates for them. The cost is the reliance in stronger assumptions regarding the structure of the error term. On the other hand, the two-stage approach does not rely in parametric assumptions to estimating the efficiency scores but it is likely to provide biased results if the first-step model is misspecified. We use the two-stage approach since we prefer a more parsimonious approach.

The two-stage approach has been questioned in several grounds. Many scholars have found the Tobit's strong distributive assumptions hard to defend. To address this issue, we implement a quantile regression model for censored data (QRC) as suggested by Powell (1986). This approach has also the advantage of allowing covariates to shift location, scale, and the entire shape of the distribution (Chernozhukov et al 2002) which permits to analyze heterogeneous effects. One drawback of the original Powell's (1986) approach is that the objective function is not convex, creating computational problems that has severely limited its practical use. This issue is addressed using the algorithm developed by Fitzenberger (1996).

[21] Recall that the estimation of efficiency scores requires the accumulation of several years of expenditures to allow for time for the public goods to be delivered/constructed. Therefore, we typically accumulate the expenditures between 2001 and 2006 (or 2007) for public goods in 2007 (or 2010). This aggregation converts our original panel dataset in a cross-section of municipalities.

Another concern is the serial correlation of the estimated efficiency scores, which put into question the standard inference procedures (Simar and Wilson 2007)[22]. In addition, the input C and the output y are correlated with MC and Z by construction, which implies that v is correlated with MC and Z. Although both problems disappear asymptotically, they do so at a low convergence rate. Simar and Wilson (2007) suggests to implement an alternative bootstrap algorithm to address these issues. However, recent work by Johnson et al (2012) suggests that these concern might be overstated and that standard two stage estimators are consistent even when correlation between inputs and contextual variables is allowed. Moreover, standard Tobit models do not necessarily require a structural interpretation if the researcher is willing to read efficiency scores simply as measures of distance to a best-practice frontier (Bogetoft and Otto 2011), although some structuralist scholars might find that questionable (Simar and Wilson 2011). Since these issues are related to the distributive restrictions implied in Tobit models, the QRC should address them.

A final point is related to the orientation of the efficiency model. In an *input-oriented model*, the emphasis in on the amount of inputs used to produce a given outcome. The *output-oriented model* pays special interest in the amount of output generated for a given level of input. We will focus on the input-oriented approach since it is the most common approach followed by the literature. This seems to be the most appropriate approach although the behavioral model behind might not be consistent with the current behavior of local government in our setting. An input-oriented approach basically assumes that outputs are exogenous and that local governments have a significant control over inputs whereas in the output-oriented approach the opposite is true. It is more realistic to expect the true behavioral model for local governments in our setting to be somewhere in the middle. Whereas local governments have most of their revenues exogenously determined, they do have some influence in the way the spend revenues to provide public goods. On the other hand, the decision regarding the quantity and type of provision of public goods are partly under their control. So, we follow the literature in its emphasis on an input-oriented approach.

We discuss the results of this approach in the following section.

[22] This is due to the fact that the estimation of efficiency scores depends on all observations, which creates this correlation by construction.

6. Empirical Results

In this section, we present results for the two proposed exercises. In the first place, we study how the boom of natural resource has impacted local governments' budgets. We then analyze whether the windfall has affect the efficiency of local government expenditure. We finally explore the role of political competition as the basic channel that explains the reduced-form results.

6.1. The impact of resource windfalls on local governments' budgets

To evaluate the impact of fiscal windfall is local governments' budgets, we run the DD model discussed above. The dependent variables are measured in nuevos soles in prices of Lima in 2001 in per-capita terms. The mining Canon transfers are measured in thousands of nuevos soles in per-capita terms. We also include the log of the real value of mineral production to account for any potential change in municipality budgets directly related to mineral exploitation.

Table II presents the results for different type of expenditures. We found that mining Canon transfers are non-linearly related to most of the expenditures categories under study with the exception of "Other current expenses" and "Debt". In cases like "Payroll", "Pensions" and "Finance investment", only one of the coefficients of the quadratic relationship is statistically significant.

The most important impact is related to "Investment". This is not surprising since local governments are required by law to use mining Canon transfers exclusively in investment. To interpret these results, it is important to consider the level of transfers allocated to a municipality given the estimated non-monotonic relationship. Since the average municipality in the sample receives 130 nuevos soles per-capita, this basically means that the effect is positive and equal to 844 nuevos soles of investment for each thousand soles of mining Canon transfers for this type of municipality. These coefficients basically imply a positive effect in all the range of possible values (maximum is 18,100 nuevos soles per-capita), although the effect is smaller (almost 100 nuevos soles in investment expenditures for each thousand soles received). These effects represent an important increase of about 300% compared to the average investment (313 nuevos soles per-capita).

There is also an important effect in the expenditure on "Goods and services", yet the effects are way more modest. The average municipality experiences an increase of 109 nuevos soles in expenditures on goods and services for each thousand nuevos soles received as mining Canon transfer. For the richest municipality, this increase is about 20 nuevos soles per each thousand nuevos soles. With the exception of Payroll, mineral production does not affect the level of expenditures.

Table III presents results of the impact of fiscal windfalls on functional expenditures. We consider the nine most important functions of local government in Peru. We find a pattern consistent with the non-monotonic relationship suggested by the theoretical literature. All the coefficients for the level and the square of mining Canon transfers are strongly statistically significant for almost all the expenditures categories studied with the exception of "Health and sanitation" in which case the coefficient for the square is not statistically significant.

The type of expenditure most affected by mining Canon transfers is "Transport", which is again consistent with the current legal framework that favors investment in infrastructure. This type of expenditure has also other economic and political properties that convert it in one of the most attractive use of mining Canon revenues. It is usually associated to construction and maintenance of roads and sidewalks, which is highly intensive in low-skilled labor, being a common way politicians use in order to get political support from citizens. It also has the advantage of serving as a signal for politicians to show citizens their quality[23].

To gauge an idea about the net effect of mining Canon transfers on transport expenditures, we proceed in the same way as above. The average municipality experienced an increase of about 250 nuevos soles in transport expenditure for each thousand nuevos soles of mining Canon transfers. The net effect for a mineral resource rich-municipality is more modest and becomes even negative for few of the richest ones.

Besides "Transport", "Planning" and "Agriculture" are the expenditures categories more benefited from the resource windfall. According to Arellano (2011b), the increase in "Agriculture" can be explained by the interest of local politicians to compensate citizens from rural areas for the potential negative effects of mining activity. It usually takes the form of irrigation projects, seed distribution or similar programs.

[23] There is ample evidence of the use of these mechanisms in mineral rich districts. See, for instance, Gil (2009) and Salas (2010) for the case of the districts in the area of influence of the mine Antamina in Ancash, and Arellano (2011b) for mineral-rich districts in Pasco and Moquegua.

To sum up, we have found in this section a strong positive relationship between mining Canon transfers and local government expenditures. In the next section, we will explore whether local governments have used these increase in budgets in an efficient manner.

6.2. Efficiency of local public spending

We first derive the efficiency frontier using the FDH approach. We focus on four sectors: transport, infrastructure, education, and health. Due to space constraints, we discuss the results for transport, although the basic results are mostly the same for the other sectors (results available in the Appendix). We focus on transport since, as discussed above, is the expenditure category that experienced the most dramatic increase as a consequence of the resource windfall. Following Herrera and Francke (2007), we use one outcome for the analysis: sidewalks and roads constructed in urban areas (in square meters). Figure 4 presents a histogram with the distribution of efficiency scores. These results suggest that local governments in Peru are very inefficient (mean score of 0.12). Figure 5 presents the efficiency frontier for the case of urban roads under the FDH approach.

Table IV presents the results of the Tobit model for efficiency scores. All the transfers, budgetary and production variables represent averages for period 2001-2007. The efficiency scores were constructed for 2010 in order to account for some time for expenditures to be converted into public goods.

Column 1 presents the results of the simplest specification in which the level and square of mining Canon transfers are included. The relationship between the level of mining Canon transfer and the efficiency score is negative (coefficient of -0.391 and standard error 0.041) and strongly significant from a statistical point of view. The square is also strongly significant (coefficient of 0.191 and standard error 0.051). Since the average mining Canon per-capita for the period is 67 nuevos soles, this implies that the efficiency score for the average municipality is negatively associated to mining Canon transfers. Only for municipalities in the top 1% of mining Canon transfers distribution the net effect is positive.

This is illustrated in Figure 6 which presents the marginal effects for the previous specification. For local government with mining Canon transfers close to the mean, we have that the effect of mining Canon on efficiency is negative (marginal effect of -0.36808). This marginal effect becomes positive for districts with average mining Canon above 1,000 nuevos soles. The economic significance of these coefficients is important. Since the average value for the efficiency score is 0.12, the impact of mining Canon on efficiency is related to an effect size of 3 for a municipality with average level of mining Canon transfers.

Column 2 adds to the previous specification the average real of production (measured in logs) for the period under analysis. We found a negative association between efficiency scores and mineral production (coefficient of -0.002, standard error 0.000). This implies that resource-rich districts are less efficient than non-producer districts after controlling for natural resource rents. This is not surprising since in many mineral producer districts mining companies have assumed a more direct involvement in the provision of public goods like health facilities, schools, and roads, or even funding social and economic projects in order to get citizens support (social license) to develop their operations and reduce social conflict[24]. This may have induced some level of inefficiency by local governments since citizens' attention is now targeted on what mining companies can directly provide to citizens.

Column 3 incorporates new fiscal variables to the previous specification. We add the average executed budget and the most important transfers from the central government, the municipal compensation fund (FONCOMUN). In both cases, the coefficients are negative and statistically significant, although the sizes of these coefficients are lower than the ones estimated for mining Canon.

Column 4, 5 and 6 add a set of control variables. Column 4 includes controls for pre-boom socio-economic characteristics using census data for 1993. These characteristics include population size, percentage of rural population, and indicators of basic needs. Column 5 adds geographical characteristics including altitude, latitude, longitude, a dummy variable for capitals of provinces, a dummy for districts located in the coast, and the distance to the capital of the province. Finally, column 6 adds region fixed effects.

Overall, the coefficients for the level and the square of mining Canon transfers retain their signs and levels of statistical significance after adding control variables. As expected, the size of these coefficients lowers as a consequence of including the control variables, but they are very robust. The economic significance of these estimates is important even for the last specification. The same robustness is observed for the case of mineral production and the average executed

[24] See Arellano (2011b) for a discussion.

budget. The coefficient of FONCOMUN is no longer significant after controlling for pre-boom socio-economic characteristics.

Table V presents the results using a DEA approach. The estimated coefficients are pretty similar to the ones found using the FDH technique. However, it is important to emphasize that similarity in coefficients is neither always expected nor relevant for the validity of our results. In fact, one should typically find efficiency scores estimated under FDH assumptions to be higher than those estimated for DEA (see, for instance, Geys et al 2009). As highlighted by Balaguer-Coll et al (2007), more relevant is that the role of explanatory variables are robust to the chosen technique, which is the case in our setting. In addition, there is some consensus that what matters is the relative performance of local governments rather than the specific value of the efficiency scores estimated for each of them.

We present in the Appendix additional evidence on this regard for other measures of public goods in education, health and infrastructure for both approaches. The results are consistent with the ones discussed in this section. In particular, the non-monotonic pattern in terms of the role of mining Canon in explaining the efficiency scores is consistent with the empirical evidence. In some cases, we have found that the specific estimated coefficients differ between FDH and DEA approaches, but that –as discussed before- it is not relevant for the validity of the analysis.

6.3. Explaining the basic results: the role of political competition

We have estimated a non-monotonic relationship between mining Canon transfers and public expenditures and their levels of efficiency. Based on the conceptual framework in section 3, we hypothesized that the dynamics of political competition matters for explaining the impact of mining Canon rents on the efficiency of local government expenditures. We formally test this mechanism in this section using longitudinal data.

Table VI explores the impact of mining Canon transfers on political competition using a DD design. The dependent variable is the measure of political competition suggested by Skilling and Zeckhauser (2002) defined as one minus the Herfindahl index of vote concentration. We use as a treatment variable the average per-capita mining Canon transfer (measured in thousands of nuevos soles in Lima 2001 prices) for the period that includes the election cycles 1998-2002, 2002-2006 and 2006-2010.

Column 1 presents the results for the specification in levels. There is no effect on political competition. However, when the square of mining Canon transfers (column 2) is included, both coefficients become statistically significant, suggesting that the linear approximation is not consistent with the empirical evidence. The coefficient associated with the transfer level is negative (-0.955), while the square is positive (0.053). The results are not altered when the logarithm of the real value of mineral production in the district is included (column 3), which suggests that changes in production levels associated with the mining boom have no impact on political competition.

Given the non-monotonic nature of the phenomenon under study, the interpretation of the results requires estimating the net effect for a given level of mining Canon rents. In this case, for a district with a level of per-capita mining Canon transfers similar to the average (109 soles per year), the total marginal effect is -0.94. In relation to the average of the measure of political competition, the size of the effect is very small, about 1%. This is because levels of political competition in Peru are very high due to political fragmentation (average of 83.15 for a measure whose maximum value is 100). The impact of mining Canon is negative for most of the districts except those with very high levels of per-capita mining rents. These districts are in the top 1% of the mining rents distribution.

Columns 4, 5 and 6 present the analysis for several sub-samples. First, column 4 excludes observations from Lima. Since Lima concentrates more than half the country's GDP, it is important to evaluate whether the study results are robust to the exclusion of districts located in this region. As implied by the size and signs of the coefficients, excluding the districts of Lima has a marginal impact on the basic results.

Column 5 shows the results of a specification that excludes observations from non-producing regions. The intuition of this specification relates to the definition of the relevant counterfactual scenario. Non-producing regions differ in several ways from producing regions so the use of the former ones as part of the counterfactual scenario could be problematic. Excluding non-producing regions from the sample restricts the comparison between mining Canon recipient districts that differ in terms of the magnitude of the rents they receive. In this scenario, the emphasis is on the intensity in which districts are treated. The econometric results suggest that this concern is not relevant in the context of this paper. The results for the level and the square are not substantially modified in terms of magnitude of the coefficients and level of statistical significance.

Column 6 follows the same logic as the previous exercise but this time only excludes from the sample non-producing provinces. Again, the main results are robust to the exclusion of these provinces in terms of the coefficient's magnitude and in relation to their levels of statistical significance. In all previous cases the logarithm of the real value of mineral production is not statistically significant, confirming that changes in mineral production have no impact on political competition.

The evidence provided in this section is consistent with the theoretical framework outlined above. Political competition seems to serve as a device that forces politicians to increase their levels of efficiency in terms of spending public resources. Although is tempting to conclude that this increase in political competition is good for citizens, the fact that the level of expenditures also show this non-monotonic relationship with mining Canon transfers casts doubts regarding this apparently beneficial effect. Since more political competition is also associated to shorter political horizons for incumbent politicians, it is possible that mayors are just increasing rents and the joint reduction in expenditures and public good provision can be consistent with an increase in efficiency.

6.4. Explaining the basic results: the role of public good provision

We turn now to the discussion about the role of public good provision. We evaluate here whether mining Canon revenues are non-monotonically related to the provision of urban roads per-capita. We estimate a cross-sectional least square specification similar to the one used in the Tobit analysis. Standard errors are clustered at district level. Results are presented in Table VII.

We find strong evidence in favor of the non-monotonic pattern previously suggested. The coefficients for the level of mining Canon and its square are strongly significant and with the expected signs. For the average municipality in the sample in terms of mining Canon transfers, the net impact is 2.895, which represents an effect size of 3.91 (mean urban roads square meters per-capita of 0.74). On the other hand, a municipality located at the 99 percentil experiences a net impact of -0.272 (negative effect size of 0.368).

Except the case of column 5, results are robust to the inclusion of budgetary, socio-economic and geographical/regional controls. In our preferred specification (column 6), the effects are larger. The net impact for the average municipality is 3.96 (effect size of 5.36).

In sum, the evidence is consistent with the theoretical framework. We evaluate the robustness of our results in the next section.

6.5. Robustness

We provide in this section additional evidence regarding the robustness of our results. The Appendix to this paper already provides additional evidence with respect the non-monotonic relationship between mining Canon rents and efficiency scores for other public goods. In this section, we relax the strong distributive assumptions associated to Tobit models using QRC model suggested by Powell (1986). Inference was conducted using the resampling approach suggested by Bilias et al (2000).

Table VIII presents the result of the empirical exercise. We consider an input-oriented FDH model for the case of urban transport as benchmark using our preferred specification with region fixed effects and controls for budgetary, socio-economic and geographical variables. We follow the current practice in quantile regression models of estimating results for different conditional quantiles. In particular, we use quantiles 0.1, 0.3, 0.5, 0.7 and 0.9 in the analysis.

The evidence suggests a pattern consistent with the non-monotonic case previously discussed. Although some of the coefficients are estimated with less precision for the case of the extreme quantiles (0.1 and 0.9), the qualitative results are essentially the same. Interestingly, the results suggest that, conditional on the set of control variables discussed above, the impacts of mining Canon transfers are larger for the most efficient municipalities. For instance, the net effect is negative (-0.276) for the municipalities at the ninth decile of the conditional efficiency distribution, assuming the average mining Canon transfer of 67 nuevos soles for the period 2001-2007. This represent a 250% decrease of the average level of efficiency in the sample (0.11). On the other hand, municipalities at the first decile have a net effect of -0.034, which represent a reduction of 30% with respect to the average level of efficiency in the sample.

It is interesting to note that results under standard quantile regression are pretty similar (see Figure A.1 in the Appendix to this paper). This is not surprising if we take into account the fact that very few observations are close to the upper value of 1. Therefore, censoring seems not to be a significant problem in the sample.

To summarize, the evidence presented in this paper seems to be robust to relaxing the distributive assumptions associated to Tobit models. The results in this section also provides evidence regarding heterogeneous effects of mining rents.

7. Concluding Remarks

This paper analyzes how fiscal windfalls related to natural resource booms affect the efficiency of local governments' expenditures. Consistent with a basic theoretical framework that highlights the non-monotonic responses associated with resource booms, we estimate a negative impact of natural resource rents on efficiency for the districts with average level of mining Canon transfers but positive effects for the case of extremely resource-rich districts. These effects are explained by the strategic behavior of local politicians in a face of a resource boom which in turn affects the provision of public goods and as a consequence the level of efficiency in the use of local government budget.

The results of this paper calls for a more nuanced view regarding the role of resource booms on efficiency and public good provision. Whereas most of the existing evidence has suggested very modest impacts of resource booms in public good provision and increases in inefficiency, some new scholarship and the evidence presented in this paper suggest that these effects are not necessarily monotonic. Given the magnitude of the shock in natural resource rents, it might be the case that previous studies are simply capturing only part of the phenomena. However, the increase in efficiency for extremely mineral-rich regions does not necessarily represent good news since is related to reductions in public good provision. We believe this is an issue that requires more future research.

Despite these results, it is important to emphasize that this perverse increase impact of political competition in efficiency is only valid for few districts with extraordinarily high levels of mining rents. For most of the local governments in the sample, the increase in mining rents seems to be related to larger levels of inefficiency, a finding consistent with the existing literature. One key contribution of this paper is to show that the relationship between natural resource rents and efficiency is quite more complex. We also emphasize the role of political competition in this regard. We believe that scholars interested in understanding the determinants of local government efficiency would be better-off by incorporating political factors into the analysis in innovative ways. We hope our paper can be seen as an example in that direction.

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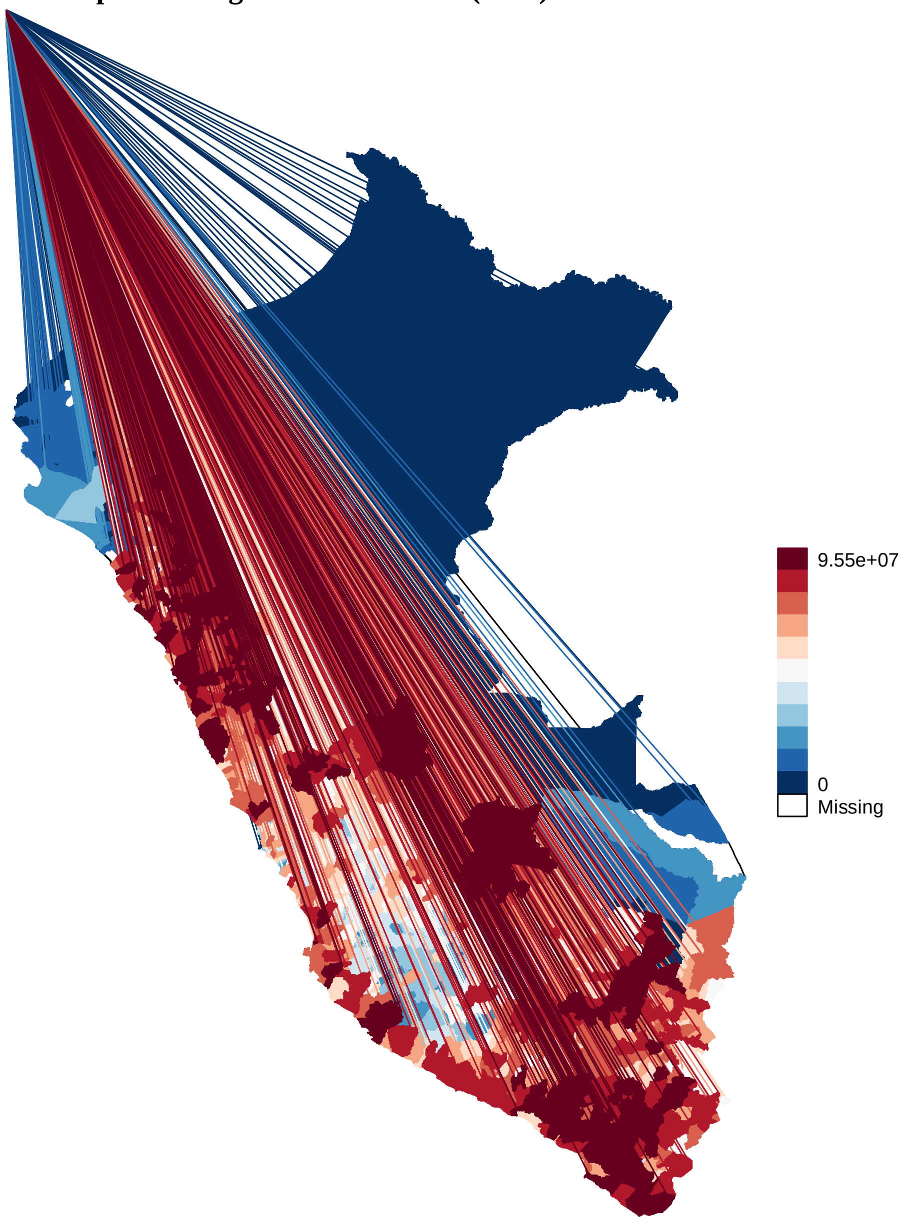
Map 1: Mining Canon allocation (2010)

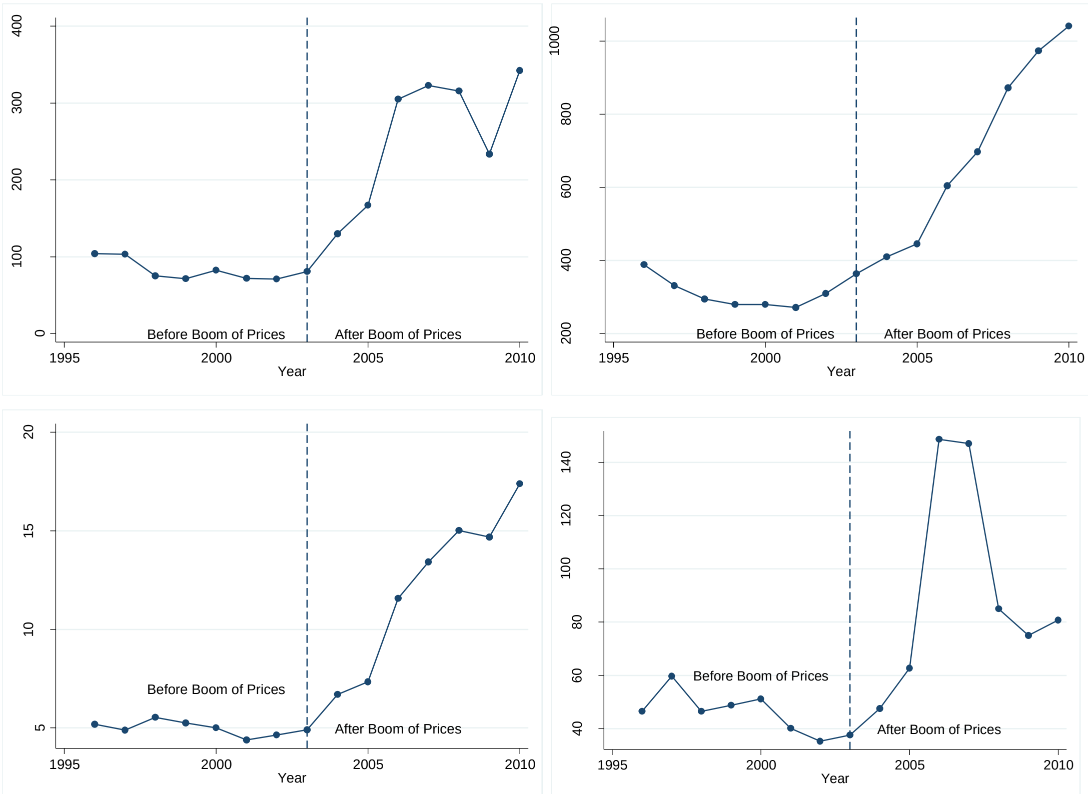


Source: Own elaboration based on administrative data from Ministry of Economy and Finance.

Figure 1: Evolution of Mineral Production

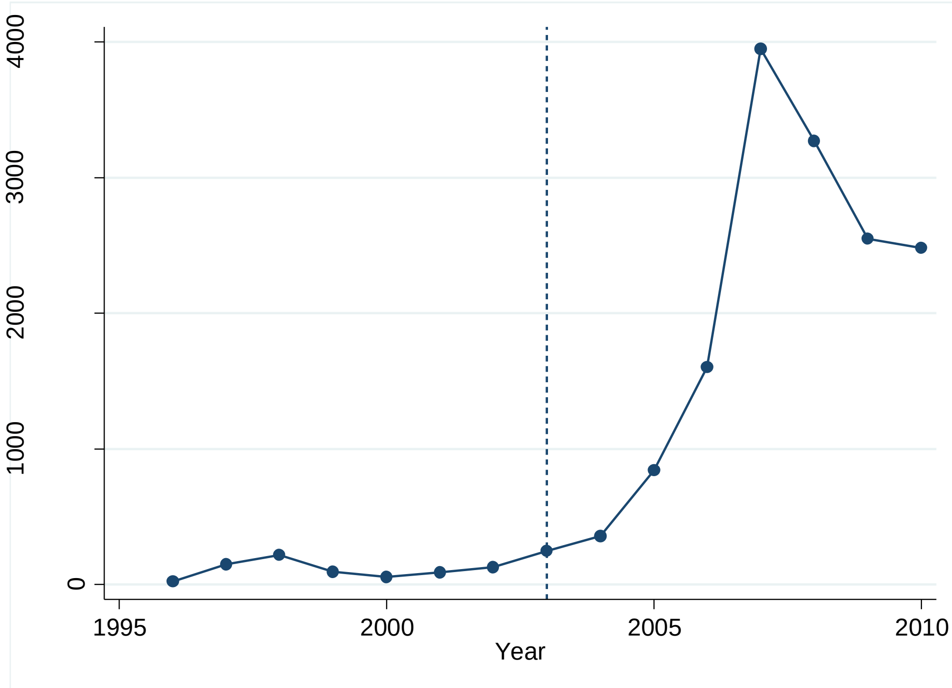
Source: Own elaboration based on administrative data from the Ministry of Energy and Mines. Calculations based on real production values in 2001 prices. Vertical line for year 2003, considered the year in which the boom started.

Figure 2: Evolution of Mineral Prices



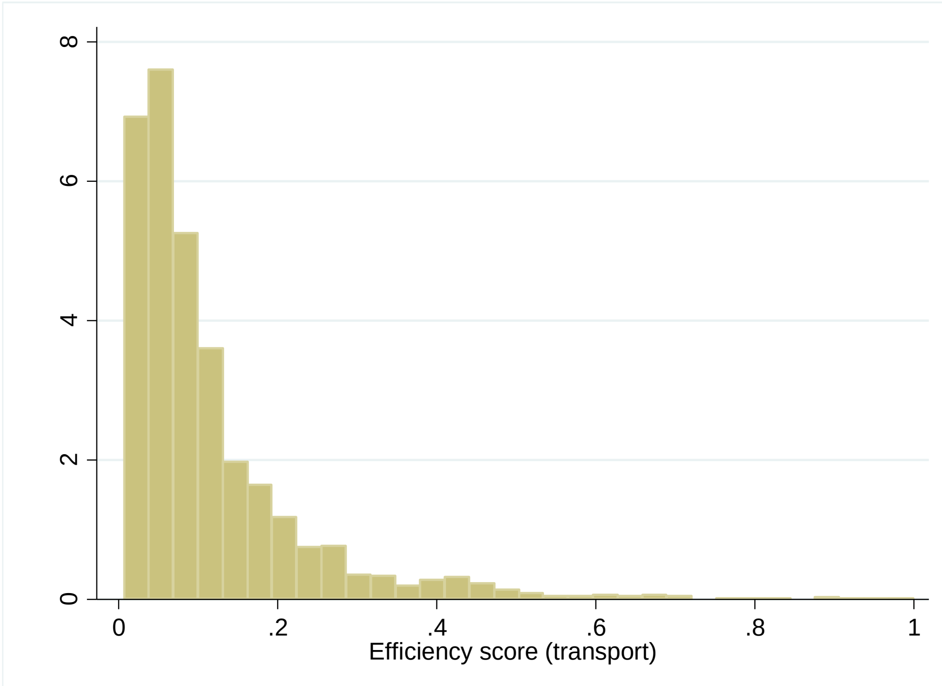
Source: Own elaboration based on administrative data from the Ministry of Energy and Mines. Vertical line for year 2003, considered the year in which the boom started.

Figure 3: Evolution of mining Canon rents distributed to local goverments (1996-2010)



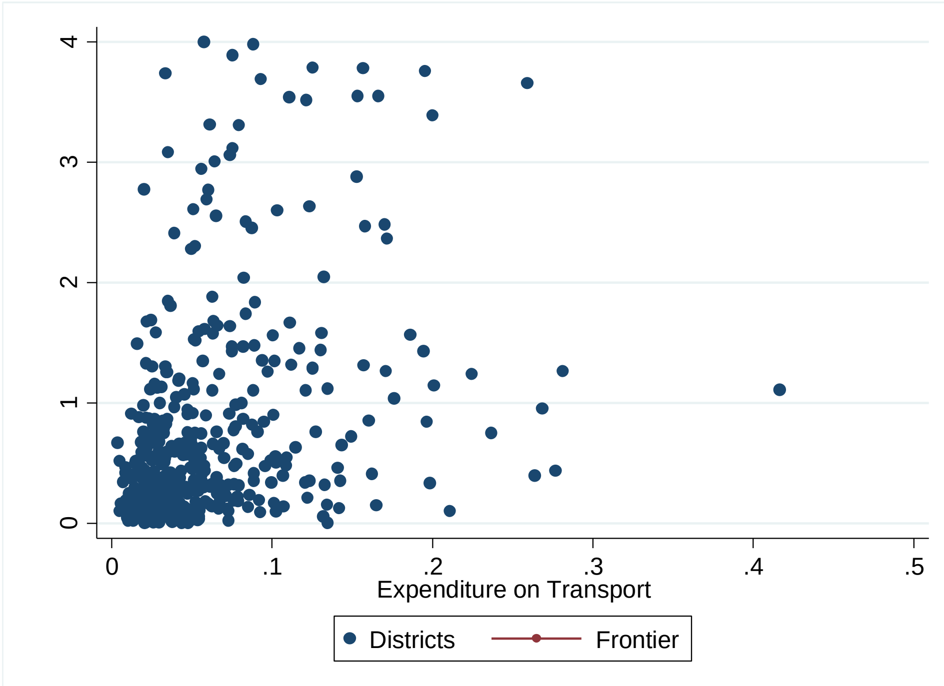
Source: Own elaboration based on administrative data from the Ministry of Economy and Finance. Monetary values expressed in 2001 Lima prices. Vertical line for year 2003, considered the year in which the boom started.

Figure 4: Histogram of efficiency scores for transport sector



Source: Own elaboration based on an input-oriented Free Disposal Hull model. The input is the average expenditure on transport for period 2001-2007. The output is square meters of urban roads per-capita in 2010.

Figure 5: Efficiency frontier for transport



Source: Own elaboration. The input is the average expenditure on transport for period 2001-2007. The outcome is square meters of urban roads per-capita in 2010.

Figure 6: Marginal effects of the impact of mining Canon on local government efficiency

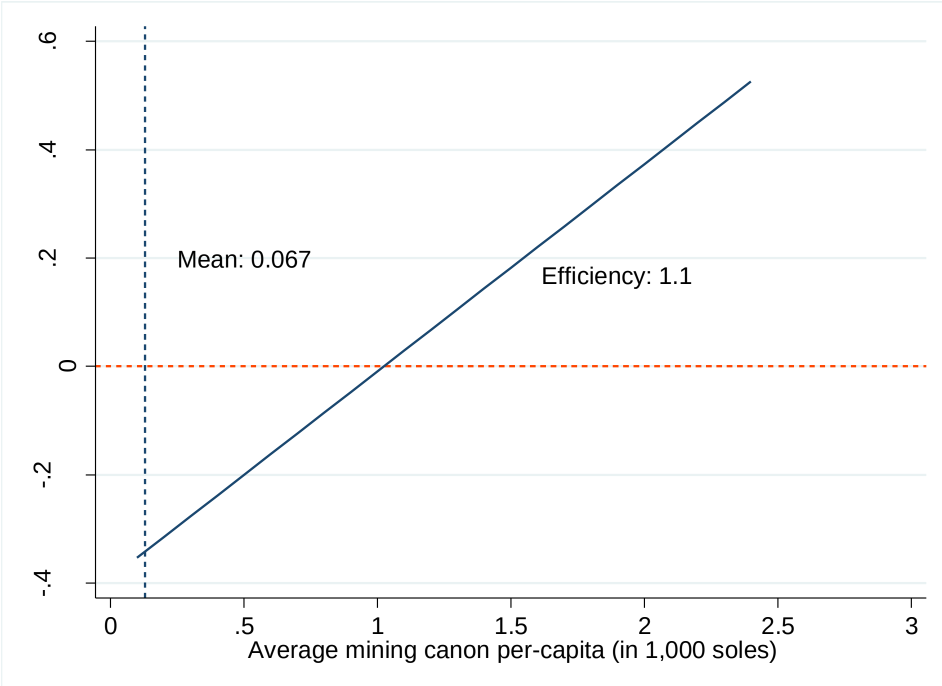


Table I: Summary Statistics

	Recipients	Producers	Non-recipients
I. Transfers			
Mining Transfers (per-capita)	92.32	474.47	-
p10	0.09	0.39	-
p25	0.70	2.64	-
p50	4.92	27.75	-
p75	44.04	281.85	-
p90	179.31	877.38	-
p99	1,272.58	9,479.57	-
Municipality Budget (per-capita)	568.03	1,496.52	347.17
II. Mineral Production			
Real Value of Mineral Production (US$ in 2001)	-	2,324,875	-
Copper	-	898,122	-
Zinc	-	490,013	-
Lead	-	69,880	-
Tin	-	134,851	-
Molybdenum	-	17,171	-
Silver	-	219,311	-
Gold	-	466,456	-
Iron	-	29,070	-
III. District Characteristics: Census 1993			
Population	12,339	10,788	22,618
% Rural Population	57.76	55.32	59.08
% Children (0-15 years old)	40.68	40.58	45.14
Malnutrition rates for Children	55.61	53.02	55.64
% Population without wastepipe-latrine	41.81	41.60	53.91
% Population without water	51.20	49.84	67.13
% Population without electricity	74.16	65.27	68.55
Female illiteracy rate	33.60	29.39	23.90
Altitude	2,326	2,720	498

Source: Own.

Table II: Impact of Natural Resource Booms on Local Government Expenditures

	Difference in Difference Estimates							
	Payroll	**Pensions**	**Goods and Services**	**Other Current Expenses**	**Investment**	**Finance Investment**	**Other Capital Expenditures**	**Debt**
Mining Canon per-capita	54.217*	0.307	119.261***	-0.147	936.501***	-0.030	9.159**	-0.226
	(31.269)	(0.208)	(29.923)	(0.439)	(68.537)	(0.019)	(4.223)	(0.934)
Mining Canon per-capita^2	-1.605	-0.018**	-3.009**	0.025	-26.704***	0.001	-0.455*	0.088
	(1.172)	(0.007)	(1.187)	(0.020)	(2.053)	(0.001)	(0.240)	(0.080)
Log of (1+Real Value of Production)	-0.551*	-0.004	-0.680	-0.073	3.775	-0.003	0.099	0.217
	(0.319)	(0.053)	(0.542)	(0.060)	(3.717)	(0.003)	(0.172)	(0.161)
Mean dependent variable	34.13	5.21	96.89	14.17	313.66	0.01	4.43	16.58
Number of observations	17,317	17,317	17,317	17,317	17,317	17,317	17,317	17,317
R2	0.101	0.721	0.238	0.043	0.488	0.002	0.019	0.083

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White standard errors clustered at the district level. All specifications include district and year fixed effects. The treatment variable is measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. Dependent variables are measured in per-capita terms.

Table III: Impact of Natural Resource Booms on Local Government Expenditures

	Difference in Difference Estimates								
	Planning	**Agriculture**	**Social Assistance**	**Education and Culture**	**Energy and Natural Resources**	**Industry, Trade and Services**	**Health and Sanitation**	**Transport**	**Housing and Urban Development**
Mining Canon per-capita	269.258***	172.590***	34.600***	178.123***	14.972***	26.074***	108.534***	279.371***	38.571***
	(51.112)	(29.931)	(3.623)	(15.997)	(2.310)	(4.732)	(20.848)	(58.986)	(5.432)
Mining Canon per-capita^2	-7.611***	-4.757***	-0.410**	-6.152***	-0.556***	-1.011***	-1.872	-9.952***	-1.348***
	(1.964)	(0.987)	(0.171)	(0.879)	(0.089)	(0.153)	(1.649)	(1.810)	(0.239)
Log of (1+Real Value of Production)	-1.287	0.310	0.167	2.048	-0.349	-0.151	1.175	-0.529	0.329
	(0.962)	(0.824)	(0.353)	(1.673)	(0.303)	(0.293)	(1.175)	(1.386)	(0.352)
Mean dependent variable	164.89	38.46	42.95	57.99	13.80	9.25	66.66	68.29	20.24
Number of observations	17,317	17,317	17,317	17,317	17,317	17,317	17,317	17,317	17,317
R2	0.296	0.144	0.116	0.259	0.032	0.058	0.232	0.219	0.051

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White standard errors clustered at the district level. All specifications include district and year fixed effects. The treatment variable is measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. Dependent variables are measured in per-capita terms.

Table IV: Determinants of Local Government Efficiency

(Urban Transport using an input-oriented FDH model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.391***	-0.378***	-0.244***	-0.207***	-0.199***	-0.132***
	(0.041)	(0.038)	(0.040)	(0.040)	(0.043)	(0.041)
Average Mining Canon per-capita^2	0.191***	0.188***	0.166***	0.153***	0.141***	0.087***
	(0.051)	(0.046)	(0.044)	(0.040)	(0.037)	(0.020)
Log of (1+Real Value of Production)		-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Average FONCOMUN per-capita			-0.054**	-0.033	-0.008	-0.047
			(0.025)	(0.026)	(0.030)	(0.032)
Average Budget per-capita			-0.079***	-0.086***	-0.082***	-0.065***
			(0.016)	(0.017)	(0.019)	(0.018)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2007. The variable used for its construction is the Urban Roads (square meters per-capita) using expenditures on Transport. The technique used was the input-oriented Free Disposal Hull (FDH). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table V: Determinants of Local Government Efficiency

(Urban Transport using an input-oriented DEA model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.388***	-0.375***	-0.271***	-0.233***	-0.249***	-0.157**
	(0.041)	(0.038)	(0.051)	(0.052)	(0.060)	(0.063)
Average Mining Canon per-capita^2	0.185***	0.182***	0.159***	0.145***	0.142***	0.080***
	(0.049)	(0.044)	(0.041)	(0.036)	(0.036)	(0.020)
Log of (1+Real Value of Production)		-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
		(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Average FONCOMUN per-capita			-0.100***	-0.082**	-0.073	-0.100**
			(0.037)	(0.039)	(0.047)	(0.051)
Average Budget per-capita			-0.054*	-0.063**	-0.052	-0.038
			(0.028)	(0.030)	(0.035)	(0.036)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2007. The variable used for its construction is the Urban Roads (square meters per-capita) using expenditures on Transport. The technique used was the input-oriented Data Envelopment Analysis (DEA). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table VI: Impact of Natural Resource Booms on Political Competition

Average Transfers for Electoral Cycle	**Difference in Differences Estimates**					
	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: (1-Herfindahl Index)*100					
Mining Canon per-capita	-0.324	-0.955**	-0.948**	-0.932*	-0.853*	-1.066**
	(0.247)	(0.473)	(0.473)	(0.475)	(0.478)	(0.518)
Mining Canon per-capita^2		0.053**	0.053**	0.053**	0.048*	0.062**
		(0.024)	(0.024)	(0.025)	(0.025)	(0.026)
Log of (1+Real Value of Production)			-0.022	-0.017	-0.021	-0.016
			(0.057)	(0.061)	(0.057)	(0.057)
Excluding Lima	No	No	No	Yes	No	No
Excluding Non-producer Regions	No	No	No	No	Yes	No
Excluding Non-producer Provinces	No	No	No	No	No	Yes
Number of observations	4,162	4,162	4,162	3,746	3,386	2,138
R2	0.132	0.133	0.133	0.141	0.143	0.160

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White standard errors clustered at the district level. All specifications include district and year fixed effects. The treatment variable is measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001.

Table VII: Public Good Provision

Urban Transport

	Cross-sectional Ordinary Least Squares Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	3.152***	2.976***	1.957**	2.166**	1.654	4.391**
	(0.812)	(0.845)	(0.852)	(0.900)	(1.135)	(1.930)
Average Mining Canon per-capita^2	-2.140**	-1.993**	-1.857**	-2.106**	-1.458	-3.514**
	(0.876)	(0.895)	(0.824)	(0.885)	(1.087)	(1.680)
Log of (1+Real Value of Production)		0.013	0.011	0.011	0.009	0.000
		(0.013)	(0.011)	(0.012)	(0.014)	(0.013)
Average FONCOMUN per-capita			1.505*	1.129	3.593***	3.096**
			(0.817)	(0.870)	(1.272)	(1.444)
Average Budget per-capita			0.652***	0.616***	0.368	0.476**
			(0.227)	(0.221)	(0.228)	(0.214)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	438	438	438	430	303	303

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White standard errors clustered at the district level. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table VIII: Determinants of Local Government Efficiency

(Urban Transport using an input-oriented FDH model)

	Censored Quantile Regression Model (Powell 1986)				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Average Mining Canon per-capita	-0.038	-0.055*	-0.107**	-0.143**	-0.303**
	(0.030)	(0.033)	(0.044)	(0.059)	(0.130)
Average Mining Canon per-capita^2	0.032*	0.054**	0.076**	0.103**	0.206
	(0.021)	(0.028)	(0.034)	(0.050)	(0.129)
Log of (1+Real Value of Production)	-0.001**	-0.001*	0.000	-0.001**	-0.002*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Average FONCOMUN per-capita	-0.012	0.006	-0.016	-0.036	-0.095
	(0.020)	(0.015)	(0.023)	(0.027)	(0.074)
Average Budget per-capita	-0.040***	-0.055***	0.041**	-0.054***	-0.041
	(0.013)	(0.011)	(0.017)	(0.017)	(0.034)
Socio-economic controls	Yes	Yes	Yes	Yes	Yes
Geographical controls	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes
Quantile (tau)	0.10	0.30	0.50	0.70	0.90
Number of observations	1,386	1,386	1,386	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Bilias's et al (2000) standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2007. The variable used for its construction is the Urban Roads (square meters per-capita) using expenditures on Transport. The technique used was the input-oriented Free Disposal Hull (FDH). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Annex 1: Rules for mining Canon distribution

Transfer	Use / Destination	Constitution base	Form of allocation of the resources	Legal base
(1) Canon 1 /	Public Investment 2 /	* 50% Income Tax 3/	* 10% to the municipalities in the district where the natural resource is located. * 25% to the municipalities of the province where the natural resource is located. * 40% to municipalities in the region where the natural resource is located. * 40% to municipalities in the region where the natural resource is located. * 25% to regional government (80% CR and 20% for regional universities).	* Constitution of Peru (Article 77) assigns to districts a share of income received by the State due to the exploitation of natural resources. * Law 27,506, Canon Law (July 10, 2001) establishes the allocation rule to local and regional governments. * Supreme Decree 005-2002-EF, regulation of Canon. * Law 28,077 (September 26, 2003) and Law 28,322 (August 10, 2004) amended several articles of the Canon Law. These modification were regulated by Supreme Decree 029-2004-EF and EF-187-2004, respectively.
(2) Mining Royalty	Public Investment	* % on the value of minerals (or its equivalent) sold according to international prices.	* 20% to the local municipality where the mining concession is located. * 20% to the municipalities of the province where the mining concession is located. * 40% to the municipalities of the region where the mining concession is located. * 15% to the Regional Government. * 5% to the universities.	* Law 28258, Law of Mining Royalty (June 24, 2004), that establishes the mining royalties, its constitution, determination, administration, distribution and use. * Law 28323, Law that modifies the Law of Mining Royalty (August 10, 2004). * Supreme decree 157-2004-EF, Regulation of the Law of Mining Royalties (November 15, 2004). * Supreme decree 018-2005-EF, which dictates complementary norms of the regulation of the Law of Mining Royalties (January 29, 2004). * Ministerial resolution 163-2006-EF-15, which establishes the exchange rate and rank for the payment of mining royalties (March 22, 2006).

1. It includes mining, oil, hydropower, fishing, forest and gas Canon.
2. Valid for all Canon except the oil Canon, in which case the assignment rule is the following: in Loreto, Ucayali and Huánuco until a 20% can be used for current expenditures. In Piura and Tumbes, 100% has to be used for public investment.
3. Some variants for the cases of the oil, gas and fishing Canon exist. For the case of oil Canon, it is constituted on 12.5% of the Value of the Production. Details for other forms of Canon are discussed on www.mef.gob.pe.

Table A.I: Determinants of Local Government Efficiency

(Total Literacy Rate using an input-oriented FDH model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.357***	-0.358***	-0.315***	-0.181***	-0.155***	-0.106***
	(0.031)	(0.032)	(0.033)	(0.028)	(0.029)	(0.037)
Average Mining Canon per-capita^2	0.271***	0.271***	0.240***	0.177***	0.165***	0.082**
	(0.041)	(0.042)	(0.041)	(0.030)	(0.036)	(0.032)
Log of (1+Real Value of Production)		0.000	-0.000	-0.001*	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Average FONCOMUN per-capita			-0.141***	-0.043**	0.000	-0.053**
			(0.022)	(0.019)	(0.021)	(0.023)
Average Budget per-capita			0.000	-0.036**	-0.034***	-0.016
			(0.012)	(0.014)	(0.012)	(0.011)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2007. The variable used for its construction is the Total Literacy Rate using expenditures on Education and Culture. The technique used was the input-oriented Free Hull Disposal (FDH). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table A.II: Determinants of Local Government Efficiency
(Total Literacy Rate using an input-oriented DEA model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.035***	-0.038***	-0.123***	-0.105**	-0.115**	-0.165***
	(0.006)	(0.005)	(0.042)	(0.043)	(0.057)	(0.047)
Average Mining Canon per-capita^2	0.018***	0.019***	0.018***	0.014***	0.014**	0.034***
	(0.006)	(0.007)	(0.005)	(0.005)	(0.006)	(0.007)
Log of (1+Real Value of Production)		0.000***	0.000	0.000	0.000	0.001***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Average FONCOMUN per-capita			-0.118***	-0.095**	-0.101*	-0.084*
			(0.042)	(0.041)	(0.056)	(0.047)
Average Budget per-capita			0.069**	0.062**	0.070*	0.059*
			(0.030)	(0.030)	(0.040)	(0.034)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2007. The variable used for its construction is the Total Literacy Rate using expenditures on Education and Culture. The technique used was the input-oriented Data Envelopment Analysis (DEA). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table A.III: Determinants of Local Government Efficiency

(Health Clinics per-capita using an input-oriented FDH model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.536***	-0.531***	-0.294***	-0.289***	-0.180***	-0.117*
	(0.049)	(0.048)	(0.069)	(0.071)	(0.053)	(0.070)
Average Mining Canon per-capita^2	0.245***	0.244***	0.208***	0.201***	0.163***	0.146***
	(0.053)	(0.052)	(0.051)	(0.052)	(0.047)	(0.042)
Log of (1+Real Value of Production)		-0.001	-0.001	-0.001**	-0.001	-0.000
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Average FONCOMUN per-capita			-0.078*	-0.075	0.005	0.048
			(0.046)	(0.047)	(0.040)	(0.043)
Average Budget per-capita			-0.141***	-0.127***	-0.165***	-0.195***
			(0.039)	(0.039)	(0.028)	(0.028)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2010. The variable used for its construction is the Health Clinics per-capita using expenditures on Health and Sanitation. The technique used was the input-oriented Free Disposal Hull (FDH). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table A.IV: Determinants of Local Government Efficiency

(Health Clinics per-capita using an input-oriented DEA model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.066***	-0.065***	-0.037***	-0.040***	-0.028***	-0.031***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.011)
Average Mining Canon per-capita^2	0.030***	0.030***	0.025***	0.026***	0.021***	0.024***
	(0.007)	(0.007)	(0.006)	(0.007)	(0.005)	(0.007)
Log of (1+Real Value of Production)		-0.000*	-0.000**	-0.000***	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Average FONCOMUN per-capita			-0.013***	-0.012***	-0.002	0.001
			(0.004)	(0.004)	(0.005)	(0.007)
Average Budget per-capita			-0.016***	-0.013***	-0.017***	-0.020***
			(0.003)	(0.003)	(0.003)	(0.005)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2010. The variable used for its construction is the Health Clinics per-capita using expenditures on Health and Sanitation. The technique used was the input-oriented Data Envelopment Analysis (DEA). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Table A.V: Determinants of Local Government Efficiency

(Sanitation coverage rate using an input-oriented FDH model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.582***	-0.575***	-0.321***	-0.299***	-0.194***	-0.143**
	(0.053)	(0.052)	(0.071)	(0.074)	(0.056)	(0.073)
Average Mining Canon per-capita^2	0.267***	0.266***	0.226***	0.220***	0.178***	0.155***
	(0.058)	(0.056)	(0.055)	(0.057)	(0.052)	(0.044)
Log of (1+Real Value of Production)		-0.001	-0.001**	-0.002***	-0.001	-0.000
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Average FONCOMUN per-capita			-0.093*	-0.057	0.014	0.027
			(0.047)	(0.048)	(0.040)	(0.044)
Average Budget per-capita			-0.150***	-0.145***	-0.175***	-0.190***
			(0.040)	(0.040)	(0.029)	(0.028)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2010. The variable used for its construction is the sanitation coverage rate using expenditures on Health and Sanitation. The technique used was the input-oriented Free Disposal Hull (FDH). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

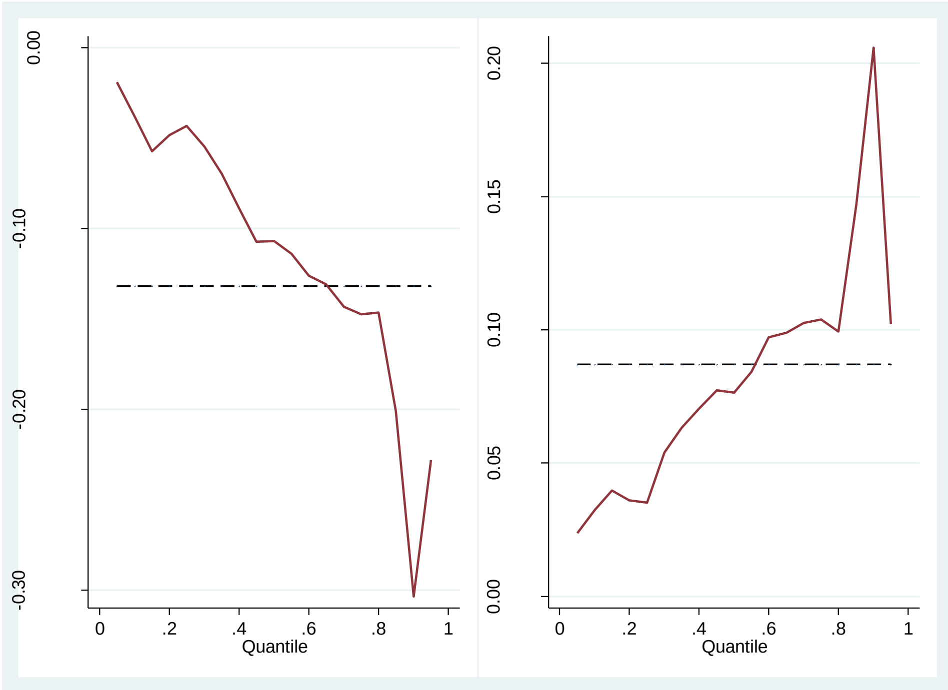
Table A.VI: Determinants of Local Government Efficiency

(Sanitation coverage rate using an input-oriented DEA model)

	Tobit Model					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average Mining Canon per-capita	-0.087***	-0.083***	-0.069***	-0.019*	-0.025**	0.007
	(0.011)	(0.011)	(0.012)	(0.011)	(0.012)	(0.019)
Average Mining Canon per-capita^2	0.045***	0.044***	0.035***	0.025***	0.026***	0.015**
	(0.013)	(0.012)	(0.010)	(0.008)	(0.008)	(0.008)
Log of (1+Real Value of Production)		-0.000***	-0.001***	-0.000***	-0.000**	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Average FONCOMUN per-capita			-0.068***	0.000	-0.006	0.007
			(0.011)	(0.009)	(0.011)	(0.018)
Average Budget per-capita			-0.001	-0.021***	-0.018***	-0.026**
			(0.005)	(0.005)	(0.006)	(0.012)
Socio-economic controls	No	No	No	Yes	Yes	Yes
Geographical controls	No	No	No	No	Yes	Yes
Region Fixed Effects	No	No	No	No	No	Yes
Number of observations	1,793	1,793	1,793	1,755	1,386	1,386

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Huber-White robust standard errors. The Mining Canon variable and its square are measured in 1,000 of nuevos soles. All monetary values are in prices of Lima in 2001. Real value of mineral production is measured in mineral prices of 2001. All independent variables are averages for period 2001-2007. The efficiency score variable is measured for period 2001-2010. The variable used for its construction is the sanitation coverage rate using expenditures on Health and Sanitation. The technique used was the input-oriented Data Envelopment Analysis (DEA). Socio-economic controls include population in 1993, percentage of rural population in 1993, population living in houses with inadequate physical characteristics in 1993, population living in households with children that are not enrolled in school in 1993, population living in overcrowded houses in 1993, population living in houses without wastepipe in 1993, and population living in houses with high economic dependency in 1993. Geographical controls include altitude, longitude, latitude, dummy for being province capital, dummy for being for being a coastal district and the distance to the capital province.

Figure A.1: Standard quantile regression coefficients



Source: Own estimated based on the standard quantile regression model without censoring. Figure reports the coefficients for the level and square of average mining Canon transfers (2001-2007). Horizontal lines represents the OLS estimates.