Local Governance in Brazilian Municipalities: The Effects of Resource Royalties*

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Existing theory suggests that the origin of public revenues affects the behavior of political decision makers. While tax revenues are expected to increase political accountability, revenues from transfers or natural resources are predicted to incur less public vigilance. This paper exploits a quasi-experimental assignment rule of natural resource royalties to municipalities in Brazil to test whether non-tax revenues are treated differently than local tax income and make politicians less responsive to their constituents. In addition, I estimate whether this relationship is mediated by the competitiveness of local elections. Royalty income is found be associated with higher spending on administration compared to local tax revenue. In addition, there is some evidence that competitive mayoral elections decrease spending on administration.

*The data and computer code necessary to replicate the results and figures in this analysis will be made publicly available at http://thomas.brambor.com upon completion of the paper. STATA 13 and **R** were the statistical packages used in this study.

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This paper re-examines the links between the sources of government funding, representation, and accountability and analyzes whether and how the sources of a government's revenues are connected to the behavior of its political actors. Existing theory commonly posits that the type of revenue a government relies on affects its behavior vis-à-vis its citizens. The fundamental distinction made in the literature is between revenues from taxation and non-tax revenues, including foreign aid and natural resource wealth. In order to raise sufficient tax revenues in the face of potential tax payer non-compliance and protest, rulers are hypothesized to enter into an implicit 'fiscal contract' – exchanging government services and improved governance for revenue (Levi, 1989; Timmons, 2004). Political representative institutions, in turn, are argued to be the necessary commitment device to make that contract durable over time (North and Weingast, 1989).

Governments with access to non-tax revenues are less reliant on the population for their revenue needs and accordingly may be less constrained in their actions. A source of government revenue that is often cast as the quintessential non-tax revenue or 'windfall revenue' is income from natural resources. There is a general understanding that income from natural resources reduces the need for taxation and as a result arguably provides less reason for publics to demand representation and more opportunity to use these monies for political or personal gain. Summarizing this ubiquitous claim, Huntington states that "oil revenues accrue to the state [..] and because they reduce or eliminate the need for taxation, they also reduce the need for the government to solicit the acquiescence of its subjects to taxation" (Huntington, 1991, p. 65). While cross-sectional evidence has revealed evidence for a correlation between exports of natural resources and the extent of democratic representation (Ross, 2001, 2004), recent analyses using better data with a focus on over-time changes rather than cross-sectional differences have found no such effect (Haber and Menaldo, 2011).

In order to provide stronger causal evidence of the connection between the composition of government revenue and representation, one would ideally want to observe exogenous changes to the sources of government revenue without accompanying direct effects on the institutional environment. This paper uses variation in the extent of the reliance on non-tax revenues in Brazilian municipalities to study the effect of different revenue structures on political accountability. In particular, the paper exploits a quasi-experimental assignment rule of natural resource royalties to Brazilian municipalities to test whether non-tax revenues are treated differently than local tax income and make politicians less responsive to their constituents. Due to Brazil's federalist structure, petroleum royalties accrue to the federal government and are subsequently partially redistributed to states and municipalities. Interestingly, this redistribution occurs largely based on the geographic distance of the receiving political units from the area of production independent of other factors, such as need or population. While some of Brazil's more than 5,500 municipalities receive over fifty percent of the value of their GDP from natural resource royalties, other nearby municipalities receive no such income - a promising analogy to the variation in cross-country analyses.

In the sections to follow, I will first provide an overview of the existing literature linking different types of revenue sources to representation and accountability. Next, the paper provides some institutional background on the case of Brazil, the role of its municipalities in public finance, and the structure of the royalty regime at the center of the analysis. After introducing the data and its descriptive patterns, the empirical analysis examines whether income from royalty income is treated differently from local tax revenue, and how this relationship depends on local politics, followed by a brief conclusion.

Theory

Government, as any other organization, needs effective oversight to function well. In democracies, regular elections provide informed citizens with the ability to hold their representatives accountable for their actions (Przeworski, Stokes and Manin, 1999). Yet, even among electoral democracies there is wide variation in the responsiveness of the political leadership to the needs and wishes of their citizens. The power of the electoral urn by itself appears to be insufficient to generate accountable and responsive governments. Research in political economy has identified a variety of culprits for hampering the translation of the electoral will into outcomes desired by a democratic majority, including uninformed and uneducated citizens, unstable political institutions, large economic inequality between the elites and the masses, and political corruption. An issue that has received particular attention, though it is usually removed from the context of democratic theory, is the observation that the reliance on non-tax revenues, including natural resource revenue (Sachs and Warner, 1995; Ross, 1999), foreign aid (Djankov, Montalvo and Reynal-Querol, 2008), and even transfers from central to subnational governments (Brollo et al., 2010), is often linked to slower economic growth, corruption, and the under-provision of public goods.

Existing theory on the concept of taxation appeals to the notion of a fiscal contract between citizens and the state. Representation is argued to derive from the link between taxation and the allocation of government revenues (Levi, 1989; Timmons, 2004). In fact, the necessity for taxation to finance government expenses may provide a lever for citizens to influence their government's actions. Citizens have preferences over taxation as well as government policies and will try to maximize their utility over these simultaneously subject to a budget constraint (Bates and Lien, 1985). If government revenues derive in large part from non-tax revenue, for example from natural resources or external rents, the influence of citizens on their representatives is arguably weakened. With the availability of such external resources, the consent of the electorate is potentially less important to political decision makers. In fact, leading this argument to its conclusion, absent the need to tax, political leaders are no longer bound to the will of their citizens, leading to a deterioration or the abandonment of democratic institutions (Ross, 2001). Models of political economy thus appear to predict that the accountability of politicians in democracies to their electorate is related to the extent to which the government relies on tax revenues from citizens instead of external income.

The evolution of the modern state in the Western World provides numerous examples of rulers establishing a state bureaucracy for taxation as a response

to their need for revenue to cover the growing expenses of war (Tilly, 1985). The establishment of public funds to be used for state affairs separated for the first time the private affairs of the princely rulers from the public common purpose of defense, hence creating the concept of the modern "tax state" (Schumpeter, 1954). In Schumpeter's words, the "financial needs" created by the requirements for warfare were the "immediate cause for the creation of the modern state" (Schumpeter, 1954, p. 19). Based on the experience of Western Europe, and here predominantly with Britain as the prime example, countries that came to depend on broad levies of taxes also tended to develop binding constraints on governments and institutionalized political representation that we now consider the hallmark of liberal democracy (Moore, 2004). Further expansions of the state bureaucracy and capacity to tax thus arguably led to demands for representation in order to allow tax payers a say regarding the spending priorities of the state and in turn enable the state to commit itself to its (tax) creditors (North and Weingast, 1989). We may conclude then that the evolution of the modern fiscal state in Western Europe laid the foundation for the subsequent development of representative institutions, leading to our understanding of a *fiscal contract* or taxation-for-representation deal.

Whether the same exchange of taxation for representation is the appropriate intuition for today's resource rich rentier states is unclear. Unlike in Western Europe's historical trajectory, in which the state was established as a strong fiscal state and subsequently turned democratic, rentier states were often weak states with little capacity to tax or provide services when statehood was established. The formation of democratic electoral institutions *before* the state has acquired the coercive capacity to tax and administrate may lead to a different relationshop altogether. In other words, if the sequence of taxation-for-representation is reversed, the relationship between taxation and representation may differ as well (D'Arcy, 2012).

Much of the empirical support for the relationship between taxation and representation comes from a wide variety of cross-country evidence, ranging from the historical experiences of advanced democracies in the Western World to the context of resource dependent governments today. It is in fact not even clear whether the insights of democratic theory gained from the expansion of the franchise in Europe (Aidt, Dutta and Loukoianova, 2006; North and Weingast, 1989) are fully transferable to the effects of natural resources on current political regimes (Ross, 2001). Moreover, in these applications, our empirical leverage is often largely gained from cross-sectional heterogeneity. In general, we observe highly democratic, high tax states in the developed world and autocratic or incomplete electoral democracies with low capacity and low tax bureaucracies in the developed world. Based on these cross-sectional correlations, we conclude that our proposed theoretical relationship between taxation and representation finds support in the data. Alternative explanations, for example that economic development may both lead to better tax capacity and lay the foundation for representative institutions, are difficult to differentiate on the basis of these data.

In order to substantiate the claim of a causal connection between taxation and representation, we would ideally want to observe exogenous changes to the composition of government funding and then use this variation to investigate changes in representative institutions. Unfortunately, in cross-country analyses

of socio-economic data such exogenous changes of government funding are hard to come by. Perhaps one of the very few exceptions is at the time of the discovery of natural resources, which often represent a shock to the funding sources of governments that has the ability to affect existing economic and political institutions (Brambor, 2012).

This paper proposes to use subnational data to test some of the implications of the theories discussed above. I argue that the receipts of royalty payments from petroleum in combination with municipal level elections in Brazil provide an interesting testing ground for the relationship between taxation and representation. Of the more than 5500 municipalities in Brazil only about 800 receive petroleum royalty payments. In fact, some municipalities receive the majority of their income from these royalties while many others receive no such income - a promising analogy to cross-country analyses. Particularly interesting for this kind of study is that the receipts of these payments are largely determined by the geographical location of municipalities in relation to the location of oil fields. Thus the distribution system itself is akin to a natural experiment because payments are based on the (exogenous) location of petroleum resources. I also use the variation in the competitiveness of mayoral and municipal council elections to test whether the use of additional funding from natural resources differs according to the local electoral context. The following section provides a brief overview of the role of municipalities in the Brazilian context and then explains how natural resource royalties are distributed at the subnational level.

Institutional Background

The Role of Municipalities in the Brazilian Federal Structure. Brazil's current highly decentralized federal structure consists of three tiers: (i) the federal government as the top tier, (ii) an intermediate tier consisting of 26 states and the Federal District, and (iii) the local tier made up of 5565 municipalities (including the capital). Brazil's seventh and most recent constitution of 1988 re-instituted a civilian democratic system after 21 years of military rule and resulted in a sharp decentralization of the administrative, political, and fiscal structure (Afonso and Barroso, 2007). In 2005, municipal level governments levied 5.8% of total taxes in Brazil, but after intergovernmental transfers accounted for 17.3% of total government spending (see Table 1). Local governments in Brazil play an essential role in the provision of public education, health care, and other public services. In fact, according to Souza (2002) local government has become the main provider of health care and it is rapidly increasing its role in primary education.

Politically, local governments play an important role as well. Every municipality (often a city or town with adjacent areas) elects a mayor (*prefeito*) and the members of a municipal council (*vereadores*) for a four-year term. Since a constitutional amendment in 1997, mayors are able to run in subsequent elections and can be re-elected once consecutively.[1] Municipal councilors are

[1]In municipalities with more than 200,000 voters a second round run-off election has to be held, should no candidate reach a majority. In practice, second round elections in mayoral elections are relatively rare.

TABLE 1. Historical Development of Federal Division of Tax Burden (1960 - 2005)

	Central	State	Local	Total	Central	State	Local	Total
	Tax Burden - in % of GDP				Composition - in % of Total			
Own Taxation								
1960	11.14	5.45	0.82	17.41	64.0	31.3	4.7	100.0
1980	18.31	5.31	0.90	24.52	74.7	21.6	3.7	100.0
1988	16.08	5.74	0.61	22.43	71.7	25.6	2.7	100.0
2005	26.72	10.01	2.26	38.99	68.5	25.7	5.8	100.0
Available Revenue								
1960	10.37	5.94	1.11	17.41	59.5	34.1	6.4	100.0
1980	16.71	5.70	2.10	24.52	68.2	23.3	8.6	100.0
1988	13.48	5.97	2.98	22.43	60.1	26.6	13.3	100.0
2005	22.53	9.70	6.76	38.99	57.8	24.9	17.3	100.0

Source: Afonso and Meirelles (2006) cited in Afonso and Barroso (2007)

elected through open-listed proportional representation. Municipal councils vary in size from 9 to 55 members according to population size (Souza, 2002).

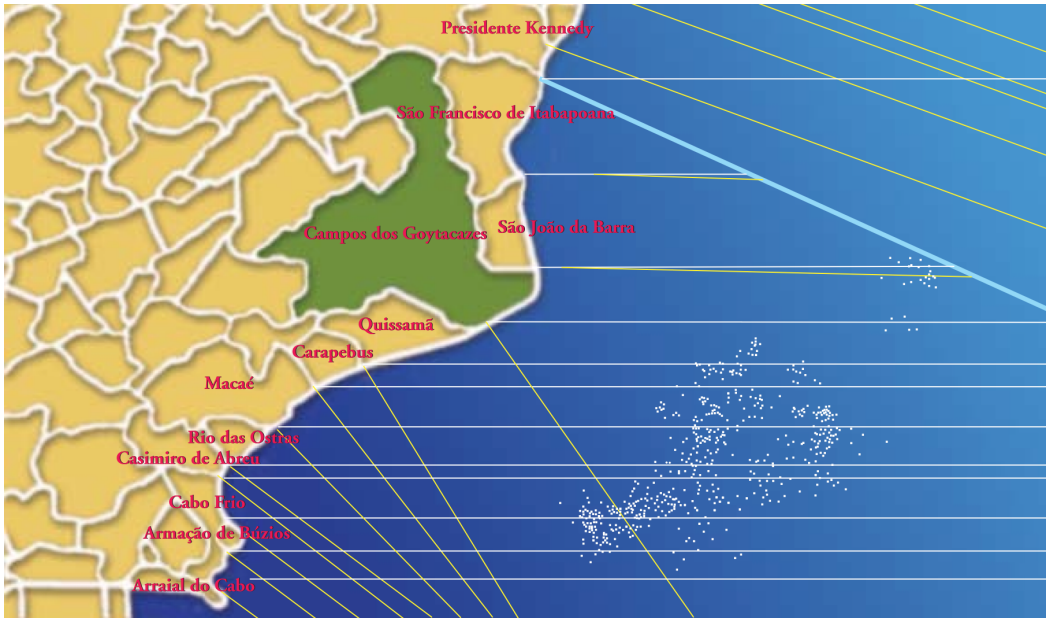
Royalty Distribution and Petroleum Law. In Brazil, petroleum royalties are paid to the central government and subnational governments.[2] These natural resource royalties were originally established in 1953 along with the foundation of the state-owned oil company *Petroleo Brasileiro SA* known as *Petrobras*. All initial oil finds were onshore and royalties were meant to compensate localities for the impact of the exploration and production of oil. Accordingly, all states and municipalities that were affected by the production or transport of oil and natural gas received royalties proportional to the value of production. The initial royalty regime was thus conceived with the expectation that future oil would be found largely on land which proved correct for the first three decades of exploration.

In the 1980s, the first significant offshore discoveries of oil deposits off the coast of the Rio de Janeiro were made. The original royalty law was not replaced but rather extended to take such off-shore production into account. In order to determine which states and municipalities should receive these royalties from offshore fields, the territorial borders of states and municipalities are projected into the ocean both orthogonally to the continental shelf and parallel to the latitude lines (see Figure 1). Many of today's oil fields in Brazil are tens or even hundreds kilometers off the coast, making the original justification of compensating localities for being affected by production and transport much less plausible.

Crucially for the empirical analysis in this paper, the geographic rule to determine which municipalities receive royalty income was established well before most of today's offshore discoveries. The formulaic assignment of these additional resources to municipalities simply according to their geographic location in relation to a producing oil or natural gas well provides a quasi-experimental

[2]A more detailed description of the historical and legal development of Brazil's royalty regime can be found in Appendix A

FIGURE 1. Determining Royalty Distribution to Brazilian States and Municipalities



Example of assignment of royalties for the coast of Rio de Janeiro.
Source: Barbosa (2001)

setting in which some municipalities receive the additional income and others do not. As a result, the receipt of royalties is independent of many other features differentiating Brazilian municipalities. While the law is obviously not exogenous to the preferences of legislators on the federal level (given that the expected outcome in revenue distribution to states and municipalities was partially foreseeable before its ratification) it is exogenous to each individual municipality. This situation thus provides a quasi-natural experiment in which we can compare the effects of the additional income on a variety of outcomes across the groups of receiving and non-receiving municipalities. Moreover, we can examine whether the effects of this additional income on the municipal level vary with the socio-economic or political conditions within municipalities.

The effects of non-tax revenue. To parse the relationship between non-tax revenue and political accountability, it helps to analytically separate the processes of receiving revenue, allocating spending in a budget, and observing the outcomes associated with the revenue spent. First, one should ask what do politicians do when they receive a no-strings-attached positive income shock to the budget of their locality? Theoretically, one could image three responses within the confines of the budget allocation: (i) increase expenditures (including for political rents), (ii) decrease taxes, (iii) save for future periods, as well as any combination of the three possibilities. Scholars in finance and economics have long been concerned with questions of income smoothing with respect to unexpected grants to local governments (Dahlberg et al., 2008). Economic theory would predict that depending on the discount factor of the relevant decision makers, an income shock should lead only to a partial increase in current spending and the remainder should be used for future consumption. Yet the empirical literature often finds that just about all of the unexpected

income shock is spent in the time period it is received, a phenomenon known as 'flypaper effect' (Hines and Thaler, Autumn, 1995). In fact, the expenditure stimulus from unconditional grants, such as resource royalties, often exceeds that from an equivalent increase in income. In the Brazilian context, I am able to test whether resource royalties are fully applied to expenditures in the period obtained, though for a political scientist a confirmative finding would be of little surprise. In addition, I can test whether these additional revenues in fact reduce the reliance on local taxation, a central claim of the resource curse literature.

Of central interest for the purposes of this paper is how this additional income is *allocated* in the budget. In general, changes in total income should lead to corresponding changes in total spending. Holding constituent preferences constant, I expect that expenditures are also increased in the proportion of the budget they constitute. This relationship I only expect to hold if citizens are equally informed about income from different sources. If, for example, local taxation allows citizens to be better informed (Gadenne, 2011) about the revenues the government has at its disposal (as opposed to transfers or windfall revenue), it may be more costly for politicians to use such resources for political rents.[3] If citizens are poorly informed about the windfall revenue available to politicians, their expectations regarding its effects may be similarly muted. For the analysis in this paper, I use local electoral competition as a proxy for the pressures on politicians to put the extra income from royalties to 'good use', i.e. not use it for administrative overhead, personnel etc. Given diverse preferences about spending among citizens, it may be difficult to ascertain if the extra income is used according to the wishes of the electorate. While it may be difficult to tell whether citizens prefer expenditures on health or education, the preferences of the majority of citizens are arguably more determinate when deciding between spending on administrative overhead and the above-mentioned public goods. In other words, one possibility is to use expenditure categories that are not associated with the provision of a well-defined public service. For example, Mendes (2005) argues that a well-defined proxy for wasteful spending in the Brazilian municipal context is 'legislative expenditure', some of which apparently ends up being used for campaign funding. Similarly, above average increases in spending on the 'cost of personnel', compared with the control group of municipalities not receiving additional royalty income, could be interpreted as evidence of self-serving behavior of local administrators or at a minimum contrary to the preferences of the citizenry at large.

To be better able to evaluate the effects of non-tax revenue on the distribution of spending, I compare the use of royalty resources to spending financed by municipal own source tax revenue. If a government's revenues come from tax revenues, politicians may be less likely to divert these revenues because citizens may be better informed about them. Gadenne (2011) finds in the Brazilian context that municipalities, which increase local tax revenue through participation in a modernization program of their tax administration, are also less likely to be found corrupt in federal audits. Paler (2011) uses an experiment embedded in a public awareness campaign to show micro-level evidence for the

[3]Strumpf (1998), an empirical paper on the 'flypaper effect' circumvents this question by simply assuming this relationship by proposing an index based on administrative expenditure which in his analysis proxies for the level of voter information.

argument that taxes indeed motivate citizens to monitor politicians and hold them accountable.

In sum, comparing the allocation of additional income from royalties to income from local taxation allows us to judge whether the allocation decisions are different depending on the source of revenue. The subsequent section introduces the empirical analysis to test some of the questions identified above.

Empirical Analysis

The main objective of this paper is to investigate whether income from oil royalties is spent differently than income from local taxation. In addition, I want to estimate whether political competition affects the spending decisions of local decision makers.

I observe a panel of about 5500 municipalities over a 10 to 15 year window (depending on the coverage of the variables used). Absent any exogenous shocks to the budgets of these municipalities our inference about the effects of oil royalties would have to be drawn from comparing royalty rich to royalty poor municipalities, much akin to a cross-country panel regression. Fortunately, the particular distribution of oil revenues in Brazil provides the analyst with two sources of exogeneity allowing to draw much stronger, potentially causal conclusions about the effects of non-tax resource revenue. First, oil revenues accrue to municipalities according to a deterministic geographic assignment rule that is exogenous to each municipality. We can thus treat resource royalties as true windfall income, the amount of which is orthogonal to any efforts of the municipality to gain such income. Second, a regulatory change of the federal oil royalty law in 1997 expanded the set of royalty receiving municipalities and increased the resource payments substantially for a subset of the recipients. Since my data measures income paid under the previous royalty regime (5 percent royalties) and the new royalties established through the law change (10 percent royalties) separately, I am able to check whether the effects of these income streams on a municipality's budget composition differ from each other as well as from the effects of other revenue sources such as local tax income.

Model. The data consists of a wide panel of more than 5500 municipalities over a time span of about ten years ("small T, large N") depending on the data availability of the measures chosen for a particular model. Since I am analyzing budget data, I expect a high degree of serial correlation. The remarkable regional diversity across Brazil suggests the use of municipal fixed effects and to allow for heteroscedasticity in the errors as well. To estimate the effects of royalty revenues on the spending patterns of local governments in Brazil I thus need to use a model that takes the shape ("small T, large N") and these particular features of the data generating process into account.

The model is specified as follows. For municipality i in year t, the per capita value for the spending category of interest, Y_{it}, is modeled as

$$Y_{it} = \rho Y_{it-1} + \gamma R_{it} + \boldsymbol{X}'_{it}\beta + \delta_t + \alpha_i + \epsilon_{it} \tag{1}$$

where Y_{it} denotes the outcome of interest (e.g. spending per capita on some budget category) for municipality i in year t. To account for the strong serial correlation in the data (usually this year's budget is very similar to last year's budget), I introduce a lagged dependent variable Y_{it-1}. R_{it} is the amount of oil royalties received, $\boldsymbol{X}_{it}$ is a matrix of independent variables, δ_t are year dummies, α_i are municipality specific fixed effects, and ϵ_{it} is the error term. The independent variables in $\boldsymbol{X}$ may include measures of the local political environment, municipal time-varying factors, and other budget items depending on the model.

Naïvely estimating equation 2 by least squares (with municipality fixed effects) would introduce numerous issues. By construction, the lagged dependent variable is correlated with the unobserved municipal effects. As a result, the simultaneous presence of a lagged dependent variable and municipal fixed effects gives rise to 'dynamic panel bias' (Nickell, 1981). If T were large, I could simply ignore this problem (Beck and Katz, 2011) but unfortunately my data does not allow me that luxury since T is simply too small to pretend that it is infinite.

The Arellano-Bond dynamic panel difference GMM estimator (Arellano and Bond, 1991) is best suited to account for the features of the data.[4] The method uses a generalized method of moments (GMM) estimator with a standard correction for small-sample bias (Windmeijer, 2005) to estimate γ, β, δ_t, α_i and ρ. The moment conditions are formed from the first-differenced errors from equation 2 and GMM-type instruments created from the lagged levels of the dependent and independent variables. The AB-GMM estimator is designed for situations with "small T, large N" panels, with fixed effects, and with heteroscedasticity and auto-correlation within units (Roodman, 2006). It is able to deal with unbalanced panels, corrects for the bias introduced by the lagged dependent variable, and allows for endogenous regressors.

Data. I use a variety of data sources, all of them available on or aggregated to the municipality-year level. The data on royalty distribution comes from Brazil's national oil company *Petróleo Brasileiro* (before 1998) and from the *Agência Nacional do Petróleo, Gás Natural e Biocombustíveis* (ANP), Brazil's National Petroleum Agency created through the 'petroleum law' in 1997 (Law No. 9478, Art.7) for later years. Data on the distribution of royalties to eligible municipalities is available from 1993 to 2011.

The data on municipal finance (FINBRA) is provided by *Tesouro Nacional* (TN), the Brazilian Department of the Treasury. Each municipality is required to submit its budgetary and financial balances to the TN. Municipal budgets are available from 1989 to 2007 with a large variation in the degree of disaggregation over the years. Fortunately for the intended empirical analysis many of the aggregated items are continuously used for the entire time period the data is available. Moreover, the number of municipalities in that time span increases from 4,278 in 1989 to 5,562 in 2006. The FINBRA data contains data on both receipts and expenditures.

[4]See Appendix B for further discussion for the benefits of the AB-GMM estimator in this context and some test for its validity in the analysis.

Detailed information on socio-economic figures for all the municipalities in the sample come from two censuses, 1991 and 2000. The data is provided by the Brazilian chapter of the UNDP in the *Atlas do Desenvolvimento Humano no Brasil* (Atlas of Human Development in Brazil) and includes more than 130 variables on income and development, education, health, inequality etc. disaggregated to the level of municipalities.

All election data are made available by the Superior Electoral Court (*Tribunal Superior Eleitoral*, TSE). GIS material to create the maps in this paper comes from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE).

Results

Before delving into multiple regression analysis, some initial exploratory graphical analysis will provide a better understanding of the data and may help to illustrate some of the patterns of interest[5].

Distribution of Natural Resource Revenues. Descriptive statistics of all variables are presented in Table 2. The top two panels of the table provide information about royalties. To the best of my knowledge, this is the first paper to analyze royalty payments for the 1990s before the foundation of Brazil's national oil agency. Other papers have used interpolations from field production data to calculate royalty payments that were *supposed to be paid out* to municipalities according to the geographic rules set out by law (Caselli and Michaels, 2011).

From 1993 to 2011 on average only about 800 out of Brazil's more than 5500 municipalities received income from oil and gas royalties. Since royalties are distributed based on the value of production of nearby fields, royalty income is distributed extremely unequally among Brazil's municipalities. The Gini coefficient of resource royalty payments is an astonishing 0.986. The top decile (about 80 municipalities) receives about 85% of all municipal oil royalties. As a result, for most of my analysis I define the Top 100 royalty receiving municipalities as the treatment group.

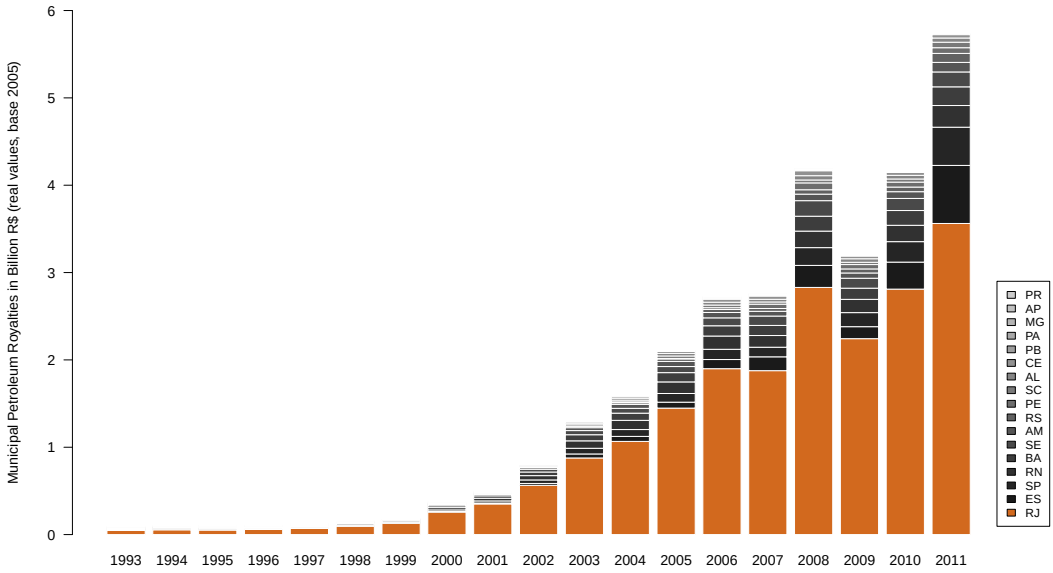
In 2011, the average per capita total royalty income among royalty receiving municipalities was about R$ 150 per capita (in 2005 Reais, approx. 75 USD at current exchange rate). The maximum total royalty income per capita was over R$ 5000 (approx. 2500 USD), received by a small (population 15,000) municipality in Rio de Janeiro state called Quissamã. Not surprisingly then, that small town had the fourth largest municipal GDP per capita (in 2008) in Brazil at over 90,000 USD. In general, many of the richest municipalities in Brazil (by per capita GDP) owe their wealth to the benefits of the royalty distribution regime.

17 of Brazil's 26 states receive royalty income (10 of which located on the coast). Since most of Brazil's oil is found off the coast of Rio de Janeiro, the state has benefitted handsomely from the royalty regime. Half of the ten richest municipalities in Brazil are located in Rio de Janeiro state. When aggregating

[5]More detailed statistical information about the distribution of the royalties is provided in Appendix

royalty income by state I find that the majority of municipal resource income - on average between 1993 and 2011 close to 65% - goes to municipalities in the state of Rio de Janeiro (see Figure 2).

FIGURE 2. Municipal Oil and Gas Royalties in Brazil (1993-2011)



Municipal Characteristics. Summary statistics of the variables on municipal characteristics are presented in the fourth panel of Table 2. The average Brazilian municipality is relatively large (area 1550 km^2), has a fairly small (population 30,000) and poor population (440 Reais per capita monthly average income in 2010). Yet, the wide ranges of variables measuring education, health, and the incidence of poverty hint at the extreme regional disparities among municipalities. For example, while in some municipalities all houses are served by running water, electricity, and regular garbage pickup, in other places almost none of the residents can enjoy these services. In terms of the statistical analysis to follow, these disparities provide an interesting variety of municipalities in the sample, but also require to account for such heterogeneity in the estimation in order to draw appropriate conclusions from the data.

Budgetary Items. One of the central tools to analyze the effects of royalties on the behavior of local decision makers is to use the distribution and change of revenues and expenditures in municipal budgets. Panel 3 of Table 2 provides summary statistics for a selected number of budget items that are available for a long enough time period to be used to study the effects of royalty receipts. The average municipality throughout the period analyzed had 830 Reais per capita (2005 constant prices) at its disposal, of which 11% was collected locally and 89% came from intergovernmental transfers. Table 4 provides the municipal budget composition of Quissamã, the municipality with the largest royalty income per capita in Brazil and provides a comparison with the average municipal budget in Brazil. Across all expenditure types, almost half the

revenue (48 percent) was spent on personnel. Accounting for expenditures by function, I find that education and culture (30 percent), health and sanitation (29 percent), housing and urbanization (14 percent), and administration and planning (20 percent) make up the lion's share of expenditures.

In the empirical analysis to follow, I use these expenditure categories as somewhat crude proxies of how royalty income is spent. For example, choosing to expand administrative expenditures more than spending on education or health could be interpreted as deviating from the interest of the municipal electorate.

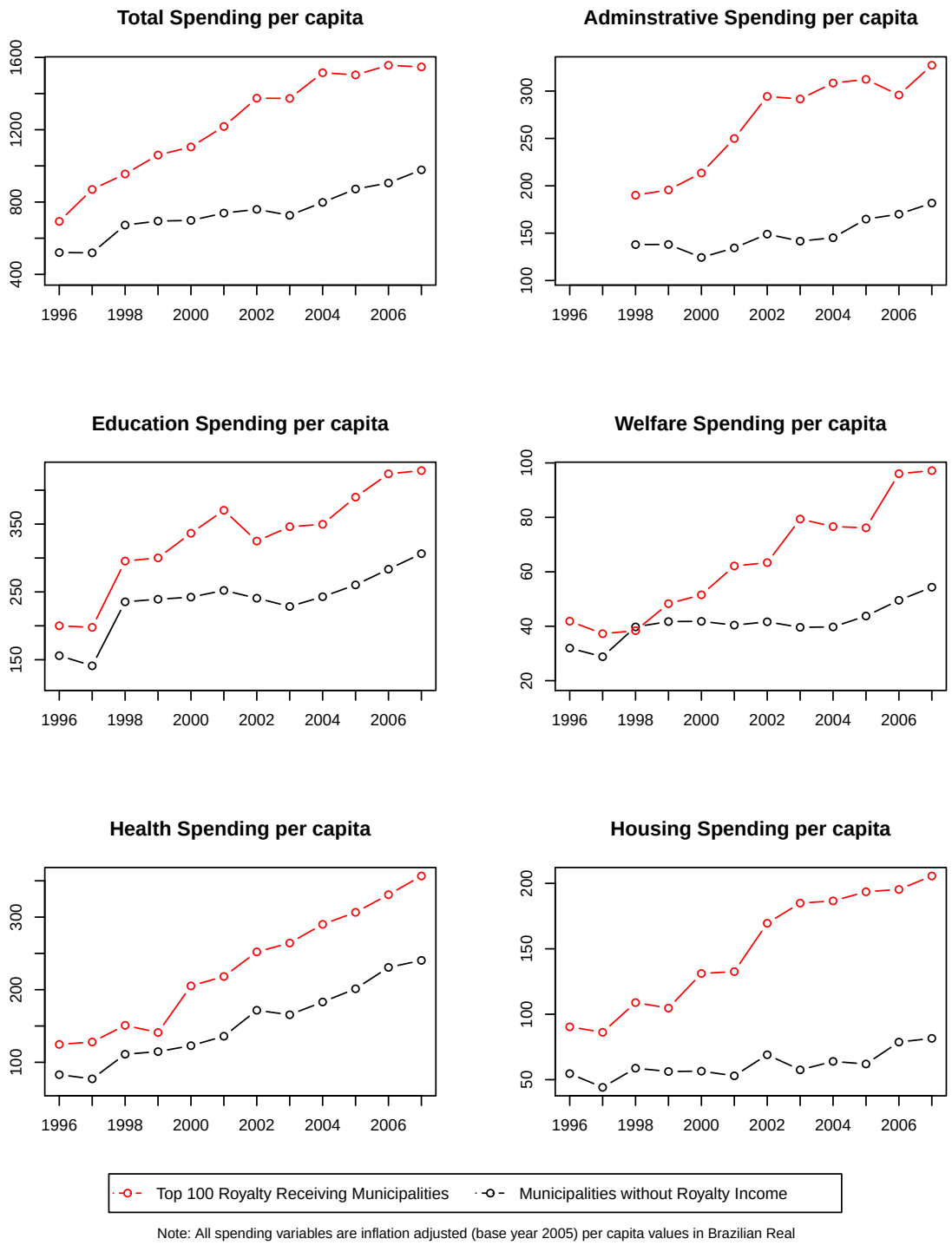
Figure 3 presents an over-time comparison of the real per-capita expenditures of the Top 100 royalty receiving municipalities with non-receiving municipalities. Unsurprisingly, royalty recipients were able to expand their overall per-capita expenditures faster than their non-oil peers. As before, administrative expenditures appear to expand somewhat faster, while education and health spending increase in sync with non-oil municipalities. Expenditures on housing and welfare among the top royalty recipients over time significantly outpace the increases within the comparison group of non-recipients.

Election Information. Municipal elections offer an opportunity to test whether electoral competition for the post of the mayor is associated with different trends in the use of royalty receipts. The last panel in Table 2 provides descriptive statistics for some of the election variables. The average winning mayoral candidate obtained the majority of the vote in the district (55 percent), while other candidates won the election with a plurality of as little as 23 percent of the vote. The average difference in vote share of the winning candidate to the runner up is a substantial 18 percentage points. As is amply known, the party spectrum in Brazil is splintered into a large number of parties with often switching coalitional alliances. Of the 32 parties in the sample, only three can claim more than a ten percent share of the mayors in the country: the PMDB with 22 percent, the PSDB with 16 percent, and the PFL with 13 percent. In about half the municipalities the mayor's party is also the largest party in the city council, which may ease opposition to the mayoral agenda in these localities. However, on average the largest party on the city council controls only about a third of the votes.

I calculate two measures of competition commonly employed in the literature on electoral systems. The first is a Herfindahl-Hirschman Index. It is computed by squaring the vote share of each candidate competing in the election and then summing the resulting numbers.[6] I calculate this Herfindahl Index for both the mayoral and city council elections. Interestingly, the measures of competitiveness for the mayoral and municipal council elections are almost completely orthogonal. For comparison, I also compute a second measure of electoral competition for the mayoral elections by simply using the difference in vote share between the winning candidate and the runner-up in the election. The two measures have a fairly high correlation of 0.61.

[6]The Herfindahl-Hirschman-Index (HHI) is calculated as $H = \sum_{i=1}^{N} s_i^2$ where s_i is the vote share of candidate i in the election, and N is the number of candidates. For simplicity of interpretation, in my empirical analysis I use the normalized Herfindahl-Index which ranges from 0 to 1 and is computed as: $H^* = \frac{H-1/N}{1-1/N}$ where H is the Herfindahl Index from above and and N is again the number of candidates in the election.

FIGURE 3. Effect of Royalties on Municipal Spending
Comparing Oil Royalty and Non−Receiving Municipalities in Brazil



Effects of Royalties on Municipal Spending. The aim is to investigate the effects of royalties on the composition of municipal budgets. For each of the models, I regress the per capita amount spent in a specific expenditure category on the per capita amount of royalties received. I selected the four largest

spending categories in the municipal budget: Administration and Planning, Education and Culture, Health and Sanitation, and Housing and Urbanization. Though wasteful and inefficient spending is certainly possible in all of these four categories, as a first approximation I suggest that spending on administration may serve as an indicator of relatively less beneficial spending. *Administrative spending* includes personnel and other costs related to general administration of the prefectures. Of course, competent administration is important and thus a valid part of any government budget. The empirical question, however, is whether royalty income is spent to a larger extent on administration compared to other parts of the budget. In all models, I also include a measure of local revenue collected by the municipality through taxes on real estate, fees etc. to compare whether tax revenue is distributed differently than windfall revenue.

In the two model specifications presented in Table 3, I model per capita spending of these four selected spending categories, namely administration, education, health, and housing as a function of royalty receipts, as well as total municipal expenditures. To check the plausibility of the results of the model setup, in columns 1 and 2 I regress total spending per capita on royalties. Assuringly, royalty receipts are fully applied to spending increases, with the long-run multiplier indistinguishable from 1[7]. Similarly, revenue from own taxation increases spending in a one-to-one relationship, again, no surprise here.

More interestingly, columns 2 and 3 reveal that on average about a quarter of royalty revenue is applied to administrative spending, but *none* of the revenues obtained from own taxation is used for administration (with the difference in the coefficients statistically significant). About 15 percent of royalty receipts are applied toward education expenditures, substantially below that category's average share of the overall budget. In contrast, an estimated 22 percent of own revenue is used for education spending. Royalties substantially increase health expenditures (23 percent) in accordance with that category's weight in the average municipal budget, in fact, substantially more so than own tax revenue. For housing expenditures neither royalties nor tax revenue show any clear association. F-tests for the difference in the effects of royalties and local tax revenue are significant only for administrative expenditure and health expenditure. In sum, I find some evidence that resource royalties are applied more towards administrative expenses. In the next section, we continue this inquiry by taking a closer look at the effects of the local political structure.

Effects of Royalties and Local Elections. Substantial increases in administrative spending represent expenditures which take away from other perhaps more beneficial spending. If citizens acknowledge this fact and are informed about the spending decisions of their local representatives, we may expect that competitive local elections for mayor and city council will increase the application of royalty transfers toward more beneficial spending categories.

In this section, I thus analyze whether the observed spending patterns differ with the electoral competition for the post of the mayor. I hypothesize that the pressures of electoral competition lead to a (relatively) more beneficial allocation of royalty payments.

[7]For each model I provide an estimate of the long-run multiplier of royalties per capita (line item "LRM Royalties") and its standard error.

In order to test the effects of electoral competition, I specify an interaction model as follows:

$$\begin{aligned} Y_{it} \;=\; & \rho Y_{it-1} + \beta_1 \text{Royalties}_{it} + \beta_2 \text{RevOwn}_{it} \\ & + \beta_3 \text{MayElecHHI}_{it} + \beta_4 \text{CounElecHHI}_{it} + \beta_5 \text{MayLargParty}_{it} \\ & + \beta_6 \text{Roy}_{it}\text{*MayElecHHI}_{it} + \beta_7 \text{Roy}_{it}\text{*CounElecHHI}_{it} \\ & + \beta_8 \text{RevOwn}_{it}\text{*MayElecHHI}_{it} + \beta_9 \text{RevOwn}_{it}\text{*CounElecHHI}_{it} \\ & + \beta_{10} \text{MayLargParty}_{it}\text{*MayElecHHI}_{it} + \beta_{11} \text{MayLargParty}_{it}\text{*CounElecHHI}_{it} \\ & + \beta_{12} \text{PartyMayor}_{it} + \text{OtherControls}'_{it}\theta + \delta_t + \mu_i + \epsilon_{it} \end{aligned}$$

Note that in addition to year and municipality fixed effects, this model includes indicators for the party of the mayor as well to account for party specific effects. The measures of electoral (non-)competitiveness employed in this analysis are Herfindahl-indexes for mayor and city council based on the vote-shares of all candidates in the last election. Moreover, I include an indicator for whether the mayor's party is also the largest party in the city council. Though the mayor is generally the most influential player in budget negotiations in Brazilian municipalities, facing little competition in the city council may further strengthen that role.

All three of these electoral variables are interacted with the total per capita royalties received by the municipality and the per capita amount of locally raised revenue. The results are provided in Table 4[8]. The dependent variable in all models remains the per capita spending in the respective budget category.

Columns 1 to 3 of Table 4 report the base model without the interactions yet but with the electoral competitiveness measures for mayor and city council included. With the inclusion of these additional variables the results from the previous section remain unchanged. None of the measures of competitiveness are directly associated with the composition of spending. In columns 4 to 6 we interact the three electoral competitive measures with total royalties per capita. There is no effect for administrative or education spending but spending on health is larger when the mayor's party is also the largest party in the city council.

In columns 7 to 9, I now present results for the full model specified in equation 2, i.e. adding interactions of electoral competitiveness with own revenue as well. In order to better interpret the marginal effects of royalty receipts and own revenue, I calculate all marginal effects over the range of their modifying variable, electoral competition. For each expenditure category, Figure 5 shows in the left graph the effect of royalties conditional on competition in mayoral elections and on the right side conditional on council elections.[9] Figure 6 repeats this exercise for locally raised revenue per capita. All figures also include a histogram of the density of the respective competitiveness measure in the data to allow the reader to judge which parts of the marginal effect plot are most relevant for the interpretation.

[8] As before, analog results of the models estimated using ordinary least squares are presented in Table 8 in Appendix C.

[9] The respective other measure of electoral competitiveness is set to its sample mean and the mayor's party is not the same as the largest party in the city council.

First, I examine the marginal effect of royalties per capita on the composition of municipal spending. For administrative expenditures, I find that the effect of royalties is increasing in the non-competitiveness of mayoral elections. For the most competitive districts (Mayoral Competitiveness HHI = 0), the marginal effect of royalties overlaps zero, indicating that royalties are applied less to administrative expenditures. In localities with less competitive elections for the mayoral office more of the income from royalties is applied to administrative expenditures[10]. The slight positive slope of the marginal effect is not significantly different from zero. The effects of royalties on education and health spending are largely unmediated by electoral pressures. For city council competitiveness, I find contrasting results. Most competitive and thus splintered city councils lead to higher spending from royalties on all spending categories. A possible explanation is that a divided city council strengthens the mayor, allowing the application of royalties to increase expenditures.

We now turn our attention to the marginal effects of locally raised revenue on municipal spending patterns (see Figure 6). Across the range of the competitiveness measures, administrative expenditures are predicted to be unaffected by increases in the revenues raised by the municipality. In contrast to royalties, we thus do not see an application of these own tax resources to administrative expenses, independent of the local political climate. As found before, education expenditures are higher in municipalities with increasing own tax resources and electoral competitiveness does not affect this relationship. Health expenditures are also predicted to increases significantly when more locally raised revenue is available, however, only in municipalities with higher electoral competitiveness of city council elections. In other words, in electorally uncompetitive (for city council) districts increases in locally raised revenue do not translate to more spending on health. The competitiveness of mayoral elections is found to have no mediating effect for health spending.

To summarize, in this section I presented evidence that income from both oil royalties and local tax revenue increased budget spending across categories. When comparing these two income sources, royalty income increases spending on administration substantially more than comparable increases in own taxation. In addition, there is some support for the hypothesis that competitive mayoral elections may decrease spending on administration, though similar mediating effects are not observed for other spending categories. While indicative, these tendencies should only be first step in the analysis. Available data for municipal budgets only provides information on broad categories of spending rather than detailed accounts of expenditure item categories.

[10]Note that, though the theoretical range of the Herfindahl-Index is from zero to one, in the data the 99th percentile for the mayoral election HHI is at 0.51 (for the council election HHI 0.65). As a result, the focus is on the range in which most observations fall, namely from 0 to 0.3 for mayoral competitiveness and 0.6 for council competitiveness. The actual distributions of the electoral competition variables are indicated in all marginal effect plots.

Conclusion

The peculiar form of resource royalty distribution in Brazil provides an excellent testing ground for the relationship between taxation and accountability. Resource royalties in Brazil accrue to municipalities based on an exogenous, geographically determined rule. In the past decade, the revenue from oil royalties from offshore oil production has expanded tremendously, leaving a small subset of coastal municipalities in Brazil with newfound riches completely independent of their own local economies and municipal characteristics. In this paper, I test whether income obtained from royalty payments is spent differently than comparable tax income, and whether these effect differ depending on the local political climate.

I present evidence that while income from both oil royalties and local tax revenue increased spending, the municipal administration chose to apply them to different areas of the budget. Royalty income is found be associated with spending on administration substantially more than comparable increases in own taxation. In addition, there is some support for the hypothesis that competitive mayoral elections may decrease spending on administration, though similar mediating effects are not observed for other spending categories.

I contend that sub-national analysis of this kind can add valuable insights for questions often asked at the cross-national level. Though this analysis treats municipal royalties as just one other type of transfer income, the analogy to countries receiving a significant share of their income from resource royalties is obvious. Mirroring evidence from the resource curse literature, I too find evidence for the application of income toward administration, exacerbated by an uncompetitive local electoral climate. Nonetheless, I also find evidence that royalties are spent on education and health as well showing that conclusions about the effects of resource income may not be as clear-cut as often made out to be.

TABLE 2. Descriptive Statistics

Variable	Mean	SD	Min	Max	n
Royalties [for *receiving* municipalities]					
Royalties all per cap	48.7	229.37	0	5978.49	15365
Royalties 5p per cap	33.11	139.58	0	2930.51	15365
Royalties 10p per cap	15.59	121.39	0	4207.93	15365
Royalties all Indicator	1	0	1	1	15375
Royalties 5p Indicator	0.97	0.18	0	1	15375
Royalties 10p Indicator	0.25	0.43	0	1	15375
Royalties [for *all* municipalities]					
Royalties all per cap	7.08	89.11	0	5978.49	105724
Royalties 5p per cap	4.81	54.47	0	2930.51	105724
Royalties 10p per cap	2.27	46.6	0	4207.93	105724
Royalties all Indicator	0.15	0.35	0	1	105773
Royalties 5p Indicator	0.14	0.35	0	1	105773
Royalties 10p Indicator	0.04	0.19	0	1	105773
Municipal Budget Items					
Revenue per cap	834	545	0	10399	90885
Revenue Own per cap	78	121	-35	1834	90794
Tax Income per cap	11	17	0	414	69624
Tax IPTUE per cap	12	29	0	486	90774
Tax Services per cap	14	33	0	576	90782
Fees per cap	41	74	-65	1264	90822
Expenditure Total per cap	790	512	0	13170	90815
Expenditure Personnel per cap	356	233	0	6593	90817
Expenditure Administrative per cap	181	143	0	3882	50922
Expenditure Legislative per cap	36	29	0	703	60496
Expenditure Education per cap	264	147	0	2404	60497
Expenditure Health per cap	172	118	0	2179	60493
Current Transfers per cap	728	468	-28	12441	90888
Municipal Characteristics					
Child Mortality 5 year	55.99	36.21	6.16	174.59	11010
Child Mortality 1 year	41.77	23.28	5.38	130.74	11010
Illiteracy 7 to 14 years	22.45	19.82	0.47	93.42	11010
Illiteracy 15 to 17 years	10.38	12.4	0	84.38	11010
Illiteracy Over 25 years	31.49	17.56	2.02	87.44	11010
Income percent from work	73.96	12.98	22.31	96.59	11010
Income per cap	244.19	192.86	24.98	1700	16575
Income Gini index	0.54	0.06	0.35	0.82	11010
House water	61	31.37	0	100	11010
House electricity	78.02	23.55	1.95	100	11010
House telephone	11.85	12.72	0	91.39	11010
House garbage	66.65	31.75	0	100	10677
Population rural	5896.62	9154.69	0	621065	16507
Population urban	22905.44	171657.17	0	11152221	16507
Population	30230.32	183702.41	365.02	11253512	133365
HDI total	0.66	0.1	0.32	0.92	11010
HDI education	0.71	0.14	0.12	0.98	11010
HDI longevity	0.68	0.09	0.42	0.89	11010
HDI income	0.58	0.1	0.31	0.92	11010
Literacy Rate	76.98	14.74	10.81	99.09	16577

Continued on next page

TABLE 2. Descriptive Statistics

Variable	Mean	SD	Min	Max	n
Elections					
Mayor Votes winner	8641.07	57228.37	0	3790558	82720
Mayer vote share	0.55	0.12	0.23	1	82716
Mayor Difference 1st and 2nd	0.18	0.2	0	1	82720
Mayor p is council largest p	0.48	0.5	0	1	75041
Council larg p in may coalit	0.35	0.48	0	1	83423
Mayor second term	0.13	0.34	0	1	127945
Council Number Seats	10.16	2.7	6	55	75104
Council Largest Party Vote Share	0.37	0.13	0.1	1	75104
Council HHI	0.25	0.11	0.03	1	75104

FIGURE 4. Municipal budget of Quissamã in comparison to average municipality in Brazil

(Measured as share of current revenue)

	BUDGET ITEMS		DISCRIMINAÇÃO	QUISSAMA - RJ			AVG. MUNICIPALITIES		
				2005	2006	2007	2005	2006	2007
1	**NON-FINANCIAL REVENUE**	1	**RECEITA NÃO FINANCEIRA**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
	REVENUE COLLECTION FOR ITSELF		**RECEITAS DE ARRECADAÇÃO PRÓPRIA**	**4.9**	**4.3**	**8.2**	**34.8**	**34.3**	**35.5**
	IPTU		IPTU	0.3	0.3	0.2	7.9	7.6	7.3
	IRRF		IRRF	1.8	1.3	1.8	10.9	11.5	11.7
	ISS		ISS	0.9	1.1	0.9	2.1	2.1	2.3
	OTHER		OUTRAS	1.9	1.6	5.2	18.4	17.6	18.9
	REVENUE TRANSFER		**RECEITAS DE TRANSFERÊNCIAS**	**95.1**	**95.7**	**91.8**	**73.9**	**74.4**	**73.1**
	FPM		FPM	3.4	3.3	2.8	19.8	18.8	19.3
	LC 87/96		LC 87/96	0.4	0.2	0.2	0.6	0.3	0.3
	ICMS		ICMS	26.5	25.5	20.8	25.9	26.5	25.3
	IPVA		IPVA	0.2	0.2	0.1	3.8	4.2	4.4
	SUS		SUS	1.3	1.5	0.9	9.5	9.9	9.8
	FUNDEF		FUNDEF	2.5	2.6	2.2	11.1	11.0	11.9
	EDUCATION SALARY / FNDE		SALÁRIO EDUCAÇÃO / FNDE	0.7	0.7	0.6	1.9	2.0	1.7
	CAPITAL TRANSFERS		TRANSFERÊNCIAS DE CAPITAL	0.0	0.0	0.0	1.3	2.4	2.3
	OTHER		OUTRAS	64.9	66.2	68.3	6.7	5.9	5.6
	(-) DEDUCTIONS FROM CURRENT REVENUE		(-) DEDUÇÕES DA RECEITA CORRENTE	4.6	4.4	4.0	6.7	6.6	7.5
2	**NON-FINANCIAL EXPENDITURE**	2	**DESPESAS NÃO FINANCEIRAS**	**97.5**	**101.8**	**96.8**	**106.7**	**110.4**	**112.2**
	STAFF		**PESSOAL**	**33.1**	**34.4**	**29.9**	**48.6**	**47.5**	**48.4**
	ASSETS		ATIVOS	26.0	28.5	23.1	38.4	38.8	41.0
	INACTIVE AND PENSION		INATIVOS E PENSIONISTAS	0.0	0.0	0.0	4.5	3.1	2.8
	OTHER		OUTRAS	7.1	5.9	6.9	5.7	5.6	4.6
	OTHER CURRENT AND CAPITAL EXPENDITURE		**OUTRAS DESPESAS CORRENTES E DE CAPITA**	**64.4**	**67.4**	**66.8**	**58.1**	**62.9**	**63.8**
	OTHER CURRENT EXPENSES		OUTRAS DESPESAS CORRENTES	54.7	59.6	54.2	48.8	50.5	51.1
	INVESTMENTS		INVESTIMENTOS	9.7	7.5	10.8	9.0	12.0	12.2
	OTHER CAPITAL COSTS		OUTRAS DESPESAS DE CAPITAL	0.0	0.3	1.8	0.3	0.3	0.5
3	**PRIMARY RESULTS**	3	**RESULTADO PRIMÁRIO**	**2.5**	**(1.8)**	**3.2**	**6.5**	**2.9**	**1.0**
4	**NET DEBT SERVICE**	4	**SERVIÇO DA DÍVIDA LÍQUIDO**	**(1.0)**	**(0.9)**	**(0.8)**	**2.2**	**2.1**	**2.4**
	INTEREST		**JUROS**	0.1	0.0	0.0	**2.5**	**2.3**	**2.2**
	DEPRECIATION		**AMORTIZAÇÕES**	0.3	0.1	0.0	**2.2**	**2.2**	**2.1**
	(-) FINANCIAL INCOME		(-) RECEITAS FINANCEIRAS	1.5	1.0	0.8	2.4	2.4	2.0
5	**FUNDING NEEDS**	5	**NECESSIDADES DE FINANCIAMENTO**	**(3.5)**	**0.9**	**(4.0)**	**(4.3)**	**(0.8)**	**1.4**
6	**SOURCES OF FUNDING**	6	**FONTES DE FINANCIAMENTO**	**0.0**	**0.0**	**0.1**	**1.0**	**1.0**	**0.9**
	Loans		**OPERAÇÕES DE CRÉDITO**	0.0	0.0	0.0	**0.4**	**0.5**	**0.7**
	Disposal of ASSETS		**ALIENAÇÃO DE ATIVOS**	0.0	0.0	0.1	**0.6**	**0.5**	**0.2**
7	**DELAYS / DISABILITY**	7	**ATRASOS / DEFICIÊNCIA**	**(3.6)**	**0.9**	**(4.0)**	**(5.3)**	**(1.8)**	**0.5**
8	**EXPENDITURE BY FUNCTION**	8	**DESPESAS POR FUNÇÃO**	**98.0**	**101.9**	**96.9**	**111.5**	**114.9**	**116.7**
	EDUCATION AND CULTURE		**EDUCAÇÃO E CULTURA**	**19.7**	**23.7**	**22.4**	**28.8**	**29.6**	**30.3**
	EDUCATION		EDUCAÇÃO	16.9	17.0	14.6	26.9	27.2	27.9
	HEALTH AND SANITATION		**SAÚDE E SANEAMENTO**	**28.1**	**28.9**	**25.8**	**28.2**	**28.8**	**29.1**
	HEALTH		SAÚDE	23.0	21.5	19.0	25.2	25.4	25.6
	SANITATION		SANEAMENTO	5.1	7.4	6.7	3.0	3.4	3.5
	ADMINISTRATION AND PLANNING		**ADMINISTRAÇÃO E PLANEJAMENTO**	**18.7**	**18.1**	**21.3**	**20.8**	**21.2**	**20.8**
	ADMINISTRATION		ADMINISTRAÇÃO	18.3	18.1	21.2	15.1	15.4	15.1
	SPECIAL CHARGES		ENCARGOS ESPECIAIS	0.4	0.1	0.1	5.6	5.8	5.7
	HOUSING AND URBAN		**HABITAÇÃO E URBANISMO**	**5.1**	**6.6**	**5.5**	**12.8**	**14.2**	**14.3**
	URBAN		URBANISMO	3.7	6.6	5.5	12.1	13.4	13.5
	Assistance and Welfare		**ASSISTÊNCIA E PREVIDÊNCIA**	**5.9**	**7.8**	**5.9**	**9.6**	**9.5**	**10.5**
	SOCIAL ASSISTANCE		ASSISTÊNCIA SOCIAL	5.9	7.8	5.9	3.2	3.3	3.3
	SOCIAL SECURITY		PREVIDÊNCIA SOCIAL	0.0	0.0	0.0	6.4	6.2	7.2
	LEGISLATIVE		**LEGISLATIVA**	**3.4**	**2.5**	**1.9**	**3.4**	**3.3**	**3.2**
	TRANSPORT		**TRANSPORTE**	**4.7**	**3.7**	**3.5**	**3.3**	**3.6**	**3.6**
	OTHER		**DEMAIS**	**12.3**	**10.6**	**10.7**	**4.6**	**4.7**	**4.9**
9	**ASSETS**	9	**ATIVO**	**66.3**	**61.4**	**59.5**	**207.5**	**208.6**	**231.5**
	FINANCIAL ASSETS		**ATIVO FINANCEIRO**	**14.0**	**11.3**	**16.1**	**20.5**	**22.3**	**24.4**
	AVAILABLE		DISPONIBILIDADES	14.0	11.3	16.1	17.5	19.5	20.8
	NON-FINANCIAL ASSETS		**ATIVO NÃO FINANCEIRO**	**50.8**	**49.1**	**42.1**	**128.5**	**127.8**	**126.7**
	ACTIVE DEBT		DÍVIDA ATIVA	1.0	1.0	0.8	68.1	68.9	70.2
	PERMANENT		PERMANENTE	48.6	47.1	38.5	57.8	56.6	53.7
10	**LIABILITIES**	10	**PASSIVO**	**66.3**	**61.4**	**59.5**	**207.7**	**208.6**	**231.5**
	FINANCIAL LIABILITIES		**PASSIVO FINANCEIRO**	**8.9**	**7.3**	**9.0**	**13.3**	**14.6**	**15.4**
	REMAINS PAYABLE PROCESSOR		RESTOS A PAGAR PROCESSADOS	1.5	0.3	0.7	6.6	7.3	7.1
	REMAINS TO BE PAID NO PROCESSOR		RESTOS A PAGAR NÃO PROCESSADOS	7.3	6.8	8.1	4.1	4.4	5.4
	NON-FINANCIAL LIABILITIES		**PASSIVO NÃO FINANCEIRO**	**0.1**	**0.1**	**0.0**	**80.6**	**79.0**	**78.4**
	DEBT		**DÍVIDA**	**0.0**	**0.0**	**0.0**	**44.1**	**41.0**	**38.4**
			INTERNA	0.0	0.0	0.0	41.0	39.3	37.0
			EXTERNA	0.0	0.0	0.0	3.1	1.7	1.3
	SHAREHOLDERS 'EQUITY		**PATRIMÔNIO LÍQUIDO**	**55.8**	**53.0**	**49.2**	**55.4**	**56.5**	**57.3**
11	**CURRENT NET INCOME (RCLif)**	11	**RECEITA CORRENTE LÍQUIDA (RCL_{if})**	**101.5**	**101.0**	**100.8**	**111.6**	**110.6**	**110.0**
12	**CONSOLIDATED NET DEBT (DCLif)**	12	**DÍVIDA CONSOLIDADA LÍQUIDA (DCL_{if})**	**(14.0)**	**(11.3)**	**(16.1)**	**23.6**	**18.7**	**14.0**
13	**CAPITAL EXPENDITURE**	13	**DESPESAS DE CAPITAL**	**10.1**	**7.9**	**12.7**	**11.6**	**14.6**	**14.9**
14	**DCLif / RCLif (%)**	14	**DCL_{if} / RCL_{if} (%)**	**(13.8)**	**(11.2)**	**(16.0)**	**21.2**	**16.9**	**12.7**
15	**DEBT SERVICE / CLK (%)**	15	**SERVIÇO DA DÍVIDA / RCL (%)**	**0.4**	**0.1**	**0.0**	**4.1**	**4.0**	**4.0**
16	**SERVICE OF NET DEBT / RCLif (%)**	16	**SERVIÇO DA DÍVIDA LÍQUIDO / RCL_{if} (%)**	**(1.0)**	**(0.9)**	**(0.8)**	**2.0**	**1.9**	**2.2**
17	**STAFFif / RCLif (%)**	17	**$PESSOAL_{if}$ / RCL_{if} (%)**	**32.6**	**34.1**	**29.7**	**43.6**	**42.9**	**44.0**
18	**INVESTMENTS / CLK (%)**	18	**INVESTIMENTOS / RCL (%)**	**9.6**	**7.4**	**10.7**	**8.1**	**10.9**	**11.1**
19	**Loans / COST OF CAPITAL (%)**	19	**OPERAÇÕES DE CRÉDITO / DESPESAS DE CAPI**	**0.0**	**0.0**	**0.0**	**3.5**	**3.2**	**4.8**

TABLE 3. Effects of Resource Royalties on Municipal Budget Expenditures in Brazil
(DV: Per Capita Spending on each Budget Category; Estimation: xtabond2)

	Total Spending		Administration		Education		Health		Housing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Y_{t-1}	0.199***	0.229***	0.174***	0.207***	0.372***	0.376***	0.198***	0.206***	0.020	0.018
	(0.062)	(0.064)	(0.065)	(0.055)	(0.111)	(0.116)	(0.052)	(0.057)	(0.018)	(0.013)
Royalties all per cap	0.778***		0.228**		0.156***		0.227***		0.178	
	(0.133)		(0.093)		(0.049)		(0.053)		(0.132)	
Royalties 5p per cap		0.924***		0.262		0.112		0.252***		0.151
		(0.268)		(0.161)		(0.100)		(0.068)		(0.182)
Royalties 10p per cap		0.939***		0.127*		0.239**		0.196		0.216
		(0.165)		(0.076)		(0.104)		(0.147)		(0.255)
Revenue Own per cap	0.767***	0.854***	0.011	0.014	0.220***	0.196***	0.086***	0.100***	0.081	0.100
	(0.158)	(0.160)	(0.055)	(0.044)	(0.065)	(0.060)	(0.030)	(0.031)	(0.081)	(0.067)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Party FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LRM Royalties	0.971		0.277		0.247		0.283		0.182	
	0.198		0.114		0.092		0.063		0.134	
N	51089	51089	41908	41908	41908	41908	41901	41901	41914	41914
N Munis	5527	5527	5475	5475	5475	5475	5475	5475	5475	5475
Avg Nr Yrs	9.2	9.2	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Wald χ^2	5949.78	5125.58	606.26	722.45	2425.11	2332.43	3233.18	3395.41	280.18	275.99
Wald χ^2 p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen J p-val	0.000	0.000	0.015	0.010	0.001	0.001	0.485	0.225	0.118	0.248
AR(2) test p-value	0.612	0.546	0.868	0.801	0.233	0.566	0.236	0.347	0.759	0.535
Nr of Instruments	110	131	97	118	97	118	97	118	97	118

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed), Heteroscedasticity robust standard errors in parentheses.
GMM-style instruments are the lagged dependent variable and the independent variables, of which the first to third lags are used. Exogenous instruments are the year dummies.

TABLE 4. Effects of Mayoral and City Council Elections on Municipal Budget Expenditures in Brazil
(DV: Per Capita Spending on each Budget Category; Estimation: xtabond2)

	Direct Effects			Interactions with Royalties			Interactions with Tax Revenue		
	Admin	Educ	Health	Admin	Educ	Health	Admin	Educ	Health
Y_{t-1}	0.176***	0.334***	0.186***	0.297***	0.416***	0.222***	0.297***	0.401***	0.226***
	(0.055)	(0.057)	(0.044)	(0.061)	(0.054)	(0.045)	(0.060)	(0.059)	(0.050)
Royalties all per cap	0.181**	0.146***	0.227***	0.200**	0.195***	0.157**	0.211**	0.242***	0.105
	(0.074)	(0.035)	(0.050)	(0.088)	(0.049)	(0.076)	(0.102)	(0.066)	(0.079)
Revenue Own per cap	-0.010	0.178***	0.077***	0.063**	0.168***	0.062**	0.068	0.119	0.183***
	(0.042)	(0.039)	(0.025)	(0.026)	(0.028)	(0.025)	(0.066)	(0.075)	(0.055)
Mayor HHI	4.854	21.789	10.892	4.098	0.165	7.328	13.502	12.019	9.378
	(20.124)	(24.439)	(21.436)	(12.590)	(18.921)	(16.898)	(17.620)	(21.087)	(21.226)
Council HHI	-116.876	-21.176	-0.373	-38.873	39.570	43.144	-39.562	24.619	98.045
	(79.686)	(80.281)	(87.057)	(62.972)	(87.555)	(62.504)	(69.960)	(92.835)	(73.812)
Mayor p is council largest p	-13.123	-0.484	32.031	0.979	10.064	21.087*	4.330	11.652	30.011**
	(17.349)	(21.001)	(21.066)	(10.132)	(14.034)	(11.218)	(10.089)	(15.536)	(12.354)
Mayor HHI X Royalties Cap				0.363	-0.080	0.139	0.411	-0.091	0.134
				(0.268)	(0.189)	(0.236)	(0.284)	(0.216)	(0.270)
Council HHI X Royalties Cap				-0.265	-0.012	0.038	-0.403	-0.282	0.147
				(0.425)	(0.255)	(0.240)	(0.426)	(0.344)	(0.243)
Mayor largest party X				-0.038	-0.024	0.107*	-0.014	-0.003	0.147**
Royalties Cap				(0.068)	(0.053)	(0.060)	(0.079)	(0.055)	(0.068)
Mayor HHI X Revenue Own Cap							-0.104	0.010	0.019
							(0.121)	(0.120)	(0.120)
Council HHI X Revenue Own Cap							0.120	0.240	-0.321*
							(0.216)	(0.243)	(0.183)
Mayor largest party X Revenue							-0.031	-0.036	-0.058
Own Cap							(0.067)	(0.047)	(0.044)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Party FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	37770	37770	37763	37770	37770	37763	37770	37770	37763
N Munis	5430	5430	5430	5430	5430	5430	5430	5430	5430
Avg Nr Yrs	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Wald χ^2	1275	6151	5244	2031	6455	5981	2187	6854	5837
Wald χ^2 p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen J p-val	0.002	0.000	0.143	0.001	0.000	0.071	0.001	0.000	0.069
AR(2) test p-value	1.000	0.647	0.191	0.297	0.661	0.228	0.284	0.611	0.287
Nr of Instruments	149	149	149	236	236	236	236	236	236

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed), Heteroscedasticity robust standard errors in parentheses.
GMM-style instruments are the lagged dependent variable and the independent variables, of which the first to third lags are used. Exogenous instruments are the year dummies.

FIGURE 5. Marginal Effect of Total Royalties per Capita conditional on competitiveness of mayoral and council elections

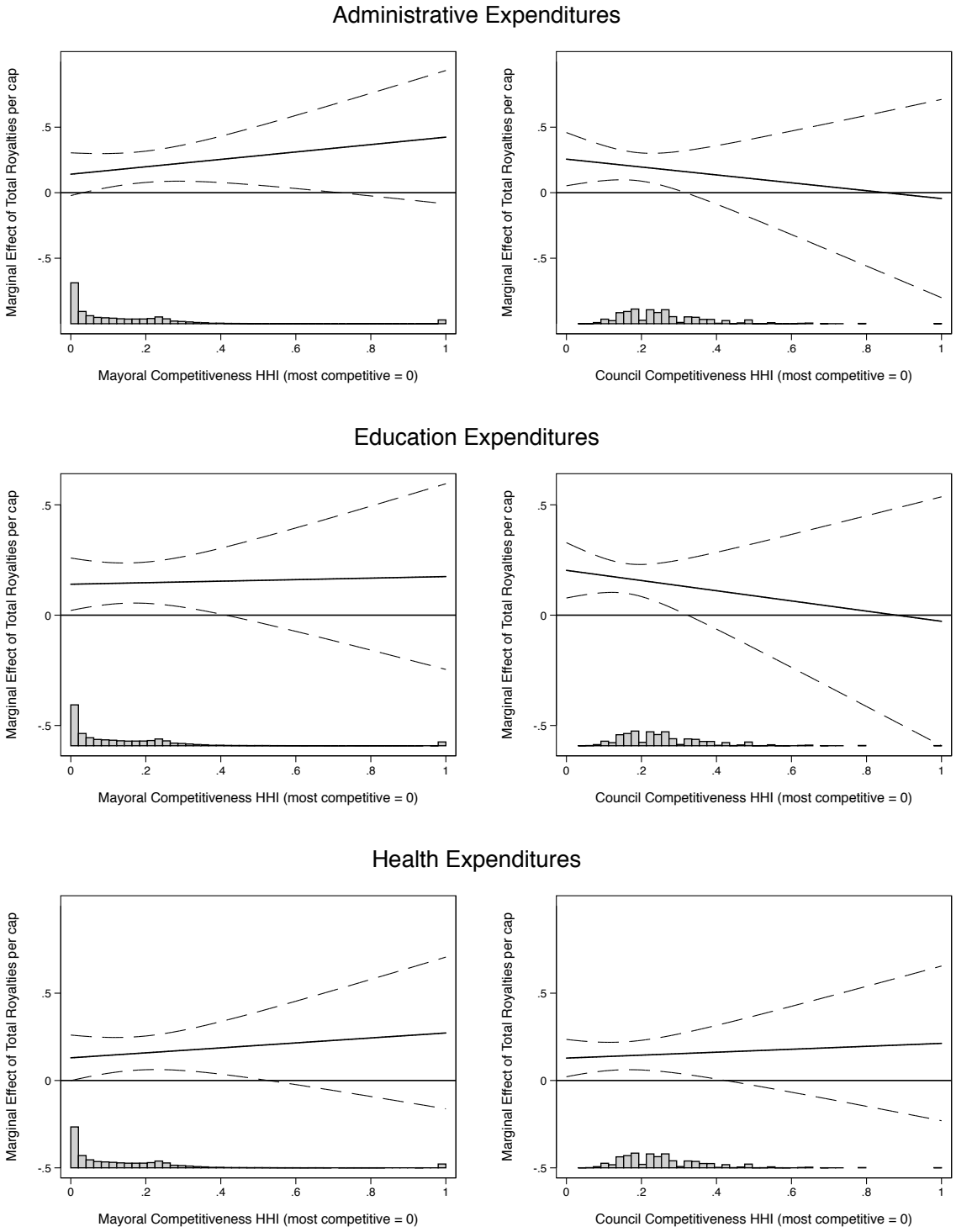
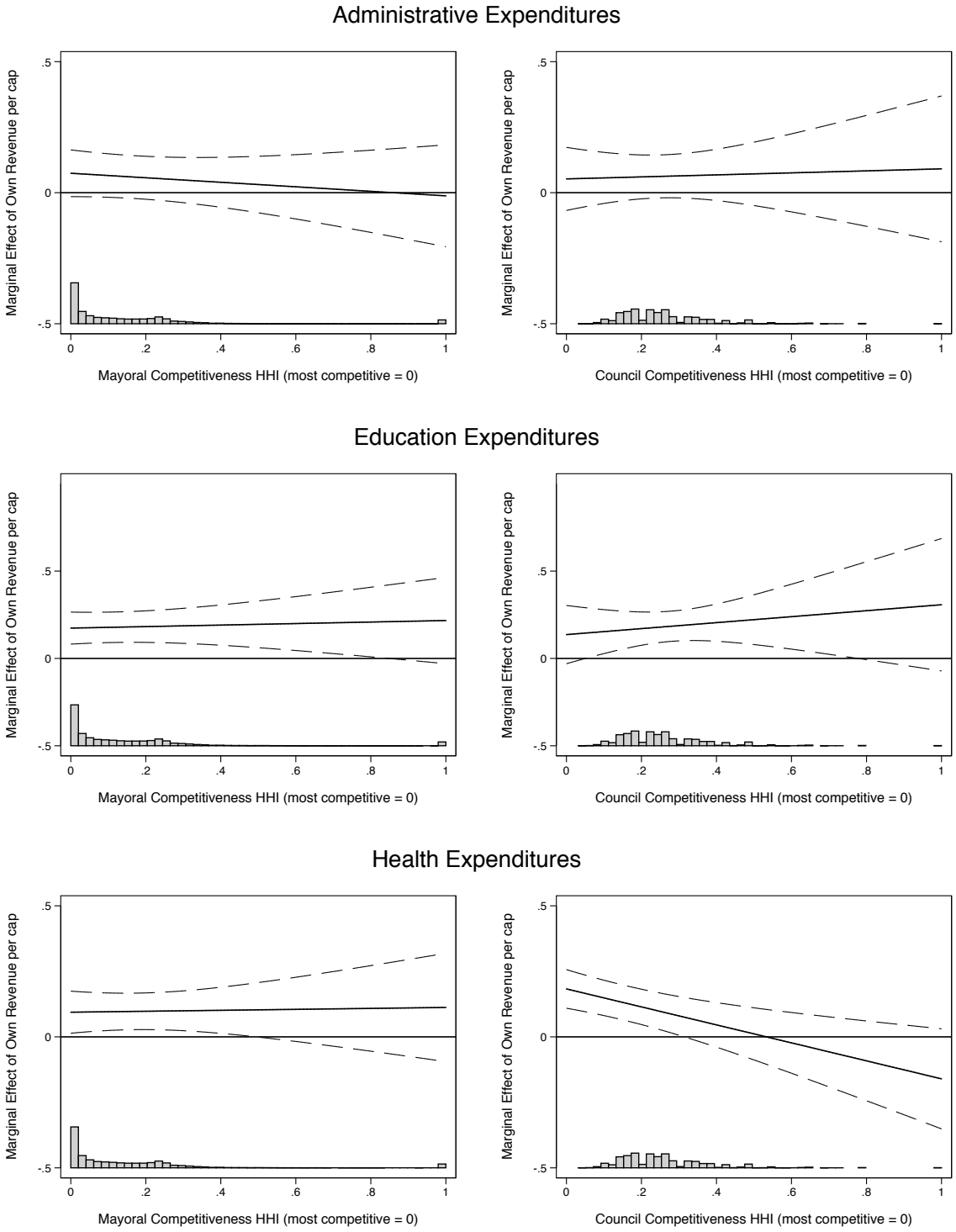


FIGURE 6. Marginal Effect of Own Revenue per Capita conditional on competitiveness of mayoral and council elections



Note: The appendices provide additional information about Brazil's resource royalty regime (Appendix A), the justification for the choice of the statistical model (Appendix B), and some additional results tables (Appendix C). None of these additional information should be required to understand the paper. Instead, they are supposed to reduce the need for lengthy footnotes and provide additional information in a concise format.

Appendix A. Royalty Regime

In Brazil, the central government along with state and municipal governments in which production occurs and which are affected by the operations of the landing and shipment of oil and natural gas receive monthly payments of petroleum royalties. These payments were established in view of the non-renewability of natural resources and are intended to financially compensate for the exploration and production of petroleum and natural gas.

These royalties were initially created in 1953 (Law No. 2004 of October 3, 1953) along with the foundation of a state-owned oil company, *Petroleo Brasileiro SA* known as *Petrobras*. Royalty payments were set to 4% of production value to the states and 1% to Municipalities where production and operation occurred. Note that at the time, Brazil only produced fairly small amounts of oil and thus these payments were accordingly rather unimportant for the receiving local and state governments. Moreover, the expectation was that hitherto undiscovered oil deposits would be found onshore and perhaps largely in the North-East of Brazil. Initially, these expectations appeared to prove correct, as the largest sites of oil production were concentrated in the states of Bahia and later in Sergipe as well.

In the 1980s, after the first significant finds of oil deposits in the Campos Basis off the coast of Rio de Janeiro and the start of offshore production, the law was extended to regulate royalty payments for these offshore sites as well (Law No. 7453 of December 27, 1985). Maintaining a 5% overall royalty tax on the value of production, 1.5% each were now distributed to states and municipalities fronting the coast where production occurred. The remaining 2% were to be distributed equally to the Navy Ministry and a special fund benefiting all states and municipalities of the federation. In order to determine to which states and municipalities the royalties from offshore fields accrue, the territorial borders of states and municipalities are projected into the ocean both orthogonally to the continental shelf and parallel to the latitude lines (see Figure 1). Moreover, municipalities are compensated differently depending on their status as principal or secondary production zones, as well as whether they are affected by the transport of oil or natural gas.

In 1997, Brazil adopted a new Petroleum Law (Law No. 9478 of August 6, 1997) that changed the calculation and redistribution of income from oil and natural gas royalties to the various levels of government. The law also ended the oil and natural gas monopoly of the state-owned company Petrobras, created the National Petroleum Agency (ANP), and increased the share of government royalties from five to ten percent of the value of crude oil and natural gas production.

As before the law, municipalities in which production occurs or which are affected by the operations of landing and shipment of oil and natural gas (Law No. 9478 - 1997, Art. 49) are entitled to a preordained share of the royalties accruing to the state. The Petroleum Law of 1997 left an existing royalties distribution scheme for royalties of up to 5% of the value of crude oil and natural gas that started in 1989 in place (Law No. 7990 - 1989, Decree No. 1 1991, see also Law No. 9478 - 1997, Art.48). Of interest for this paper are specifically the additional revenues from royalties derived from increased government participation. Royalties exceeding five percent of the value of production are distributed as follows: (i) If production occurs onshore, 15% goes to municipalities where production occurs and 7.5% to municipalities affected by operations; (ii) If production occurs offshore, 22.5% goes to municipalities fronting the production areas, and 7.5% to municipalities affected by operations.[11]

The formulaic assignment of these additional resources to municipalities simply according to their geographic location in relation to a producing oil or natural gas exploratory block provide a quasi-experimental setting in which some municipalities receive the additional income and others do not, independent of many other features differentiating Brazilian municipalities. While the law is obviously not exogenous to the preferences of legislators on the federal level (given that the expected outcome in revenue distribution to states and municipalities was partially foreseeable before its ratification) it appears to be exogenous to each individual municipality. If so, I can use the quasi-experimental variation in the receipt of this additional income across municipalities to make inferences about governance related issues on the level of local governments.

Summary Statistics and Spatial Patterns. From 1993 to 2011 on average only about 800 out of Brazil's 5500+ municipalities (or approximately 15%) received income from oil and gas royalties. Among the set of receiving municipalities, localities designated as "producing municipalities" - usually the ones fronting the coast towards the offshore fields (and independent of whether there is actually any oil infrastructure in the municipality) - receive by far the largest payments. Neighboring municipalities and those located in 'secondary zones' receive a far smaller share of the largesse. It is thus no surprise that income from resource royalties is distributed extremely unequally among Brazil's municipalities. The Gini coefficient of resource royalty payments is an astonishing 0.986. The top decile (about 80 municipalities) receives about 85% of all municipal oil royalties. As a result, for most of my analysis I define the Top 100 royalty receiving municipalities as the treatment group.

The laws defining the set of recipients of royalties before the 1997 Petroleum law (royalty payments up to 5% of the value of production of oil and natural gas) and after the change (royalties up to 10% of the production value) are based on similar geographic criteria. However, they differ with respect to the definition of production locations (wells vs. blocs) and in their description of what it means to be "affected by production". As a result, while there is some overlap of recipient municipalities, they are not identical.

[11]The remainder of these royalties goes to states where production occurs or which front the production areas, the Ministry of Science and Technology, the Navy Ministry, and a Special Fund distributed among all states, territories, and municipalities.

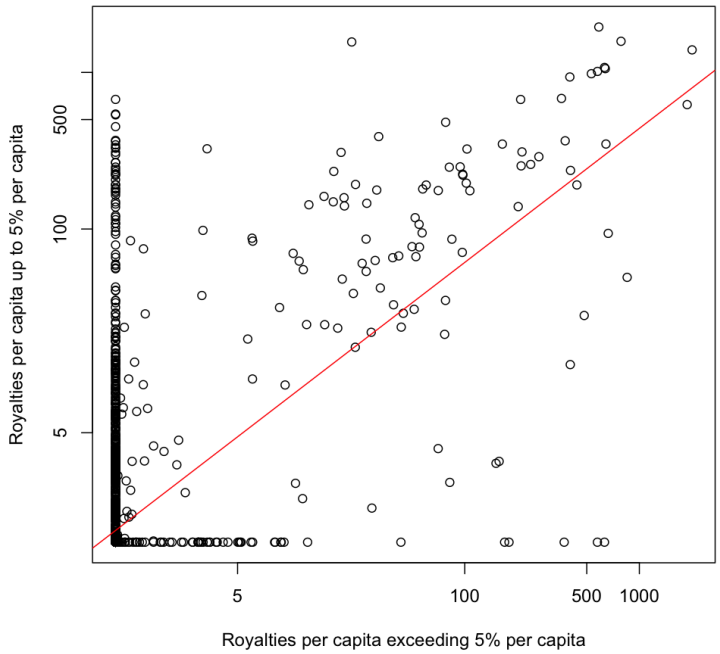
TABLE 5. Contingency table - Types of Royalty Incomes (in 2007)

		Royalties <5 Percent		
		0	1	
Royalties 5-10 Percent	0	4,604	723	5,327
		83.6%	13.1 %	96.8%
	1	46	132	178
		0.8%	2.4%	3.2%
	Total	4,650	855	5,505
		84.5%	15.5%	100%

Pearson $\chi^2 = 481$ Pr $= 0.000$

In 2007, out of all royalty receiving municipalities, 723 received only the royalty payments that remained unchanged by the 1997 Petroleum Law, 132 municipalities received royalties under the old and new regime, while only 46 municipalities exclusively received 10% royalties, i.e. the royalties established by the 1997 law change (see Table 5). Part of the challenge of the paper is thus to control for changes in the 5% royalties over time to assess separately the effect of the 10% royalties which started after the petroleum law. A plot of the logged royalties of 5 percent versus 10 percent royalties (Figure 7) shows that there is indeed a positive relationship between the amounts of the two kinds of royalties for municipalities receiving both.

FIGURE 7. Comparing Royalty Regime before (less than 5%) and after (5 to 10%) the Petroleum Law



Given the overwhelming concentration of Brazilian oil production offshore, and here specifically off the coast of Rio de Janeiro state, there exists a significant

cross-state variation in royalty receipts (see Figure 8). Overall, 17 of the 26 Brazilian states receive *some* royalty income, 10 of which are on the coast and are benefitting from offshore oil production.

Even the log-scaled figures 7 and 8 already reveal a wide variation in the amount of royalties municipalities receive. In 2011, the average per capita total royalty income among royalty receiving municipalities was about R$ 150 per capita (in 2005 Reais, approx. 75 USD at current exchange rate). The maximum total royalty income per capita was over R$ 5000 (approx. 2500 USD), received by a small (population 15,000) municipality in Rio de Janeiro state called Quissamã. Not surprisingly then, that small town had the fourth largest municipal GDP per capita (in 2008) in Brazil at over 90,000 USD. In fact, when taking a look at the table of the municipalities with the largest municipal GDPs per capita in Brazil from 1999 to 2004 (see Table 6), there are a number of other municipalities with large royalty incomes.

TABLE 6. Ranking of Municipalities by GDP per capita (1999- 2004)

Municipalities and Federative Units	Position of ten municipalities with largest GDP per capita						Population in 2004	
	1999	2000	2001	2002	2003	2004	Total	Relative (%)
São Francisco d.C. (BA)	1	1	1	1	1	1	29383	0.02
Trifuno (RS)	2	2	2	3	2	2	24343	0.01
Quissamã (RJ)	9	3	3	2	3	3	15319	0.01
Porto Real (RJ)	29	28	4	6	7	4	14326	0.01
Paulínia (SP)	7	4	6	9	4	5	58827	0.03
Carapebus (RJ)	15	7	5	4	5	6	9951	0.01
Rio das Ostras (RJ)	20	9	7	5	6	7	45755	0.03
Cascalho Rico (MG)	4	8	12	15	9	8	2618	0.00
Araporã (MG)	8	6	10	14	11	11	5790	0.00
Macaé (RJ)	42	18	13	10	10	10	152063	0.08

Source: IBGE, Directoria das Pesquisas, Coordenação de Contas Nacionais

São Francisco do Conde houses the second biggest refinery plant, in terms of installed capacity of production of barrels in the country. Triunfo hosts the headquarters of an important petrochemical plant in the metropolitan area of Porto Alegre. Quissamã, Carapebus, Rio das Ostras and Macaé all benefited from offshore exploration of petroleum and natural gas and are considered major zones for petroleum production. Note that almost all of the municipalities (except Macaé) also have low population concentrations (IBGE, 2008).

Location of Royalty Receiving Municipalities. The spatial locations of royalty receiving municipalities are mainly on the coast and in the South of the country (see Figure 9). The municipal fixed effects in the empirical model subsume the use of further municipal specific geographic identifiers such as latitude, longitude, location on the coast, micro-regions, and state fixed effects. The clustering of royalty receiving municipalities along the coast is due to the fact that royalties from offshore blocs usually accrue to municipalities closest to the location of oil and gas fields[12]. In Figure 9 one can also see again that royalties paid out under the rules before the Petroleum law (top panel) are similarly

[12]A cartogram map (not shown here) confirms that the distribution of the municipalities of interest is geographically clustered. It appears that there are a few large clusters of royalty receiving municipalities related to the spatial location of oil and gas fields. This clustering

geographically distributed to the additional new royalties instituted in 1997 (bottom panel) confirming the patterns indicated in the previous section.

is confirmed by more rigorous measures of global and local spatial auto-correlation and local Moran statistics in particular.

FIGURE 8. Royalties by State

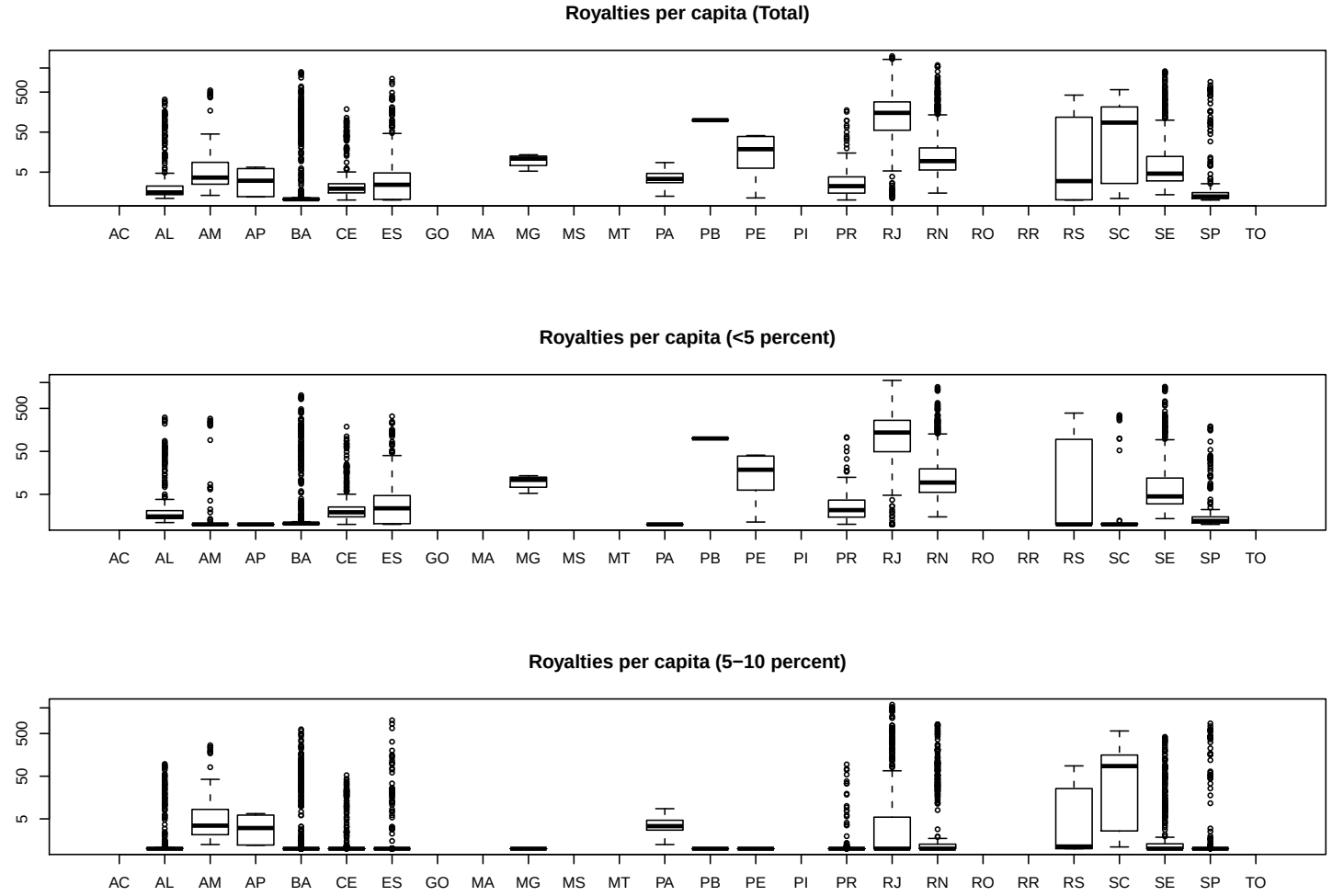
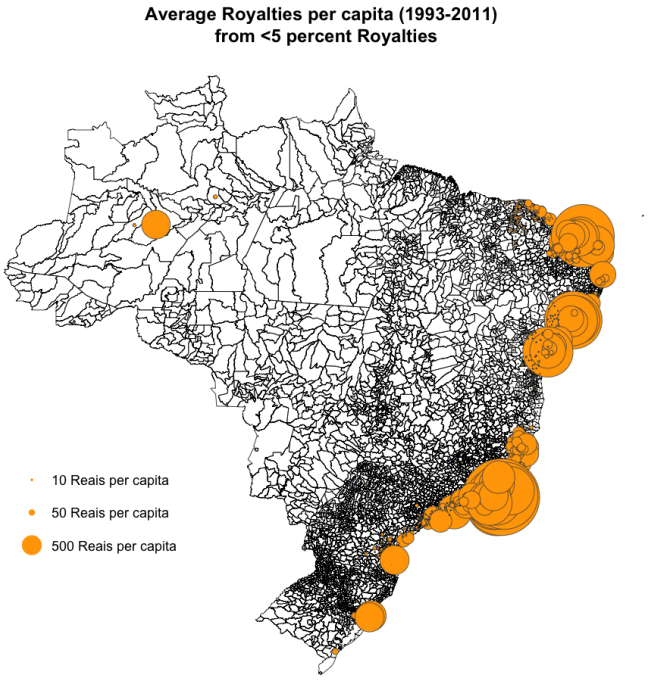
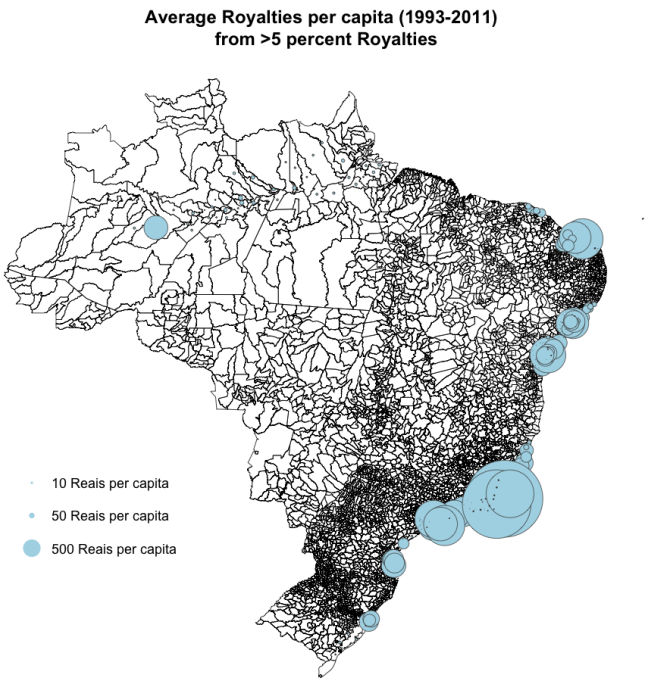


FIGURE 9. Geographical Distribution of Royalties in Brazil





Appendix B. Statistical Model

The data for the empirical analysis is a wide panel (5500 municipalities) over a relatively short span of time (10 years). In addition, I expect substantial heteroscedasticity and strong serial correlation. A model that takes the shape ("small T, large N") and these particular features of the data generating process into account is the Arellano-Bond dynamic panel difference GMM estimator (Arellano and Bond, 1991).

The dependent and independent variables of the model are specified in level, per capita values. There are multiple alternatives to specify both the dependent as well as the independent variables. First, I decided to normalize by population rather than the overall budget or parts thereof because population changes occur slowly and thus the change in the ratio measure is largely attributable to the numerator rather than unduly being influenced by changes in the denominator. Second, I do not log the per capita values because I am interested in how each Brazilian Real (R$) of royalty revenue is used in the budget. Logging the per capita royalty measures would (i) assume a reduced effect of the marginal real at higher levels of royalty income and (ii) change the interpretation to elasticities, and (iii) distort the results for the many observations of very small (less than 1 Real per capita) municipal budget category expenditures. As a result, I use non-logged, per capital values for the budget measures.

Each spending category of interest, Y_{it}, is modeled as

$$Y_{it} = \rho Y_{it-1} + \gamma R_{it} + \boldsymbol{X}'_{it}\beta + \delta_t + \alpha_i + \epsilon_{it} \tag{2}$$

where Y_{it} denotes the outcome of interest (e.g. spending per capita on some budget category) for municipality i in year t, and Y_{it-1} is the lagged dependent variable . R_{it} is the amount of oil royalties received, $\boldsymbol{X}_{it}$ is a matrix of independent variables, δ_t are year dummies, α_i are municipality specific fixed effects, and ϵ_{it} is the error term. The independent variables in $\boldsymbol{X}$ may include measures of the local political environment, municipal time-varying factors, and other budget items depending on the model.

Naïvely estimating equation 2 by least squares (with municipality fixed effects) would introduce 'dynamic panel bias' (Nickell, 1981). Kiviet (1995) proposes a way to handle dynamic panel bias by initially estimating the simple Least Squares Dummy Variables model (LSDV) and then correcting the results for the bias. Unfortunately, Kiviet's estimator is only applicable to balanced samples and does not address the potential endogeneity of other regressors.

The Arellano-Bond dynamic panel difference GMM estimator (Arellano and Bond, 1991) is best suited to account for the features of the data.[13] The method uses a generalized method of moments (GMM) estimator with a standard correction for small-sample bias (Windmeijer, 2005). I only present the more efficient two-step GMM estimates that are robust to heteroscedasticity. In Monte Carlo studies the estimated asymptotic standard errors of the two-step GMM estimator have been found to be downward biased in small samples. As

[13]For an excellent overview of panel data estimation techniques in general and the Arellano-Bond Dynamic Panel GMM Estimators more specifically see Roodman (2006).

a result I use a bias correction suggested by Windmeijer (2005) to correct for that bias.

The moment conditions are formed from the first-differenced errors from equation 2. Since I am dealing with an unbalanced panel I actually use forward orthogonal deviations (Arellano and Bover, 1995) as recommended by Roodman (2006). Unlike first differences (FD) for which I subtract the previous observation from the contemporaneous one, forward orthogonal deviations (FOD) subtract the average of all future observations of a variable. For unbalanced data, FD quickly reduce the available number of observations for analysis, while FOD are computable no matter how many gaps are in the data. FOD are determinable for all observations except the last for each subject, so it minimizes data loss. In addition, since I do not need lagged observations to compute FOD, they remain valid as instruments. For further information on how to calculate FOD see Arellano and Bover (1995) and Roodman (2006, p. 20). Also see Hayakawa (2009) for a Monte Carlo analysis documenting the superiority of FOD over FD in GMM models. For simplicity of exposition I refer to first-differences in the paper.

Suitability of Arellano-Bond Dynamic Panel GMM Model. The goal for using the AB-GMM estimator is to solve the estimation problem posed by the combination of a short panel, a dynamic dependent variable, fixed effects, and the paucity of reliable external instruments. To make sure that the estimation appropriately utilizes the estimator, I run a variety of tests outlined below[14].

A standard specification test for two-step GMM is the Hansen (1982) J test. It is a commonly employed test of instrument validity in the presence of heteroscedasticity with a null hypothesis of joint validity of all instruments. Note, that the null hypothesis can also be rejected if the model is misspecified. I report the Hansen J statistics for all AB-GMM estimations. Across most of the models, I cannot reject the null hypothesis of instrument validity[15]. The GMM estimators employed in this paper rely on lagged levels of the independent and dependent variables as instruments. As T grows larger the instrument count can quickly grow large and weaken inferences from the Hansen J test. Though the sample is large, I follow the guidelines in Roodman (2009) and restrict myself to using only lags one to three for GMM instrumenting.

The first-differencing employed through the GMM estimator addresses first-order serial correlation, a serious concern for the budget data variables I use. The p-value for the Arellano-Bond test for second-order serial correlation is presented for all models (named "AR(2) test p-value"). In every case I am unable to reject the null of no higher-order serial correlation, a good basis for the plausibility of my results on that front.

[14]For unconvinced readers, we also present the simple OLS results in Appendix C (see Tables 7 and 8), which should be viewed with all the methodological problems outlined above in mind.

[15]In a few models, the test indicates a rejection of the null of instrument validity. In these cases I am in the tricky situation of choosing between inference from the potentially biased and inconsistent AB-GMM estimator and the biased OLS results. Absent additionally exogenous instruments this presents a methodological impasse.

GMM estimation does not allow me to estimate a R-squared to judge model fit. Instead I provide a Wald-χ^2 for each model for overall fit along with a p-value of the statistic.

Appendix C. Additional Tables

Table 7. Effects of Resource Royalties on Municipal Budget Expenditures in Brazil
(DV: Per Capita Spending on each Budget Category; Estimation: xtreg)

	Total Spending		Administration		Education		Health		Housing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Y_{t-1}	0.421***	0.418***	0.367***	0.367***	0.370***	0.370***	0.343***	0.341***	0.038*	0.037*
	(0.041)	(0.041)	(0.033)	(0.033)	(0.011)	(0.011)	(0.019)	(0.019)	(0.020)	(0.019)
Royalties all per cap	0.738***		0.187***		0.164***		0.186***		0.271*	
	(0.098)		(0.030)		(0.024)		(0.036)		(0.144)	
Revenue Own per cap	0.554***	0.557***	0.093***	0.093***	0.126***	0.126***	0.121***	0.121***	0.118***	0.119***
	(0.043)	(0.042)	(0.012)	(0.012)	(0.011)	(0.011)	(0.010)	(0.010)	(0.018)	(0.018)
Royalties 5p per cap		0.437***		0.171***		0.131***		0.120***		0.085
		(0.110)		(0.062)		(0.027)		(0.040)		(0.114)
Royalties 10p per cap		1.096***		0.205***		0.200***		0.286***		0.476
		(0.179)		(0.056)		(0.044)		(0.066)		(0.424)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Muni FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Party FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LRM Royalties	1.274		0.296		0.261		0.283		0.281	
	0.157		0.050		0.037		0.054		0.150	
N	56634	56634	47439	47439	47439	47439	47432	47432	47445	47445
N Munis	5545	5545	5531	5531	5531	5531	5531	5531	5531	5531
Avg Nr Yrs	10.2	10.2	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
R-Sq within	0.62	0.62	0.25	0.25	0.44	0.44	0.55	0.55	0.12	0.12
R-Sq between	0.90	0.90	0.89	0.89	0.88	0.88	0.81	0.81	0.36	0.35
R-Sq overall	0.79	0.79	0.69	0.69	0.70	0.70	0.64	0.64	0.24	0.23
Error Structure	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed), Heteroscedasticity robust standard errors in parentheses.

TABLE 8. Effects of Mayoral and City Council Elections on Municipal Budget Expenditures in Brazil
(DV: Per Capita Spending on each Budget Category; Estimation: xtreg)

	Direct Effects			Interactions with Royalties			Interactions with Tax Revenue		
	Admin	Educ	Health	Admin	Educ	Health	Admin	Educ	Health
Y_{t-1}	0.372***	0.367***	0.344***	0.371***	0.367***	0.344***	0.371***	0.367***	0.344***
	(0.035)	(0.012)	(0.021)	(0.035)	(0.012)	(0.021)	(0.034)	(0.012)	(0.021)
Royalties all per cap	0.188***	0.167***	0.185***	0.243***	0.193***	0.205**	0.253***	0.209***	0.200**
	(0.030)	(0.024)	(0.036)	(0.057)	(0.041)	(0.093)	(0.057)	(0.039)	(0.097)
Revenue Own per cap	0.089***	0.118***	0.119***	0.091***	0.119***	0.119***	0.075***	0.087***	0.124***
	(0.013)	(0.011)	(0.010)	(0.013)	(0.011)	(0.010)	(0.023)	(0.017)	(0.019)
Mayor HHI	2.958	2.104	-1.191	2.833	2.268	-1.166	2.301	-1.886	-0.240
	(2.538)	(2.545)	(2.583)	(2.546)	(2.542)	(2.595)	(3.729)	(3.256)	(3.421)
Council HHI	-3.322	10.936*	-2.715	-2.164	11.242**	-2.072	-8.036	4.096	0.708
	(6.466)	(5.693)	(5.424)	(6.170)	(5.664)	(5.411)	(7.410)	(6.859)	(6.455)
Mayor p is council largest p	-0.738	-0.382	2.952***	-0.474	-0.348	2.762***	-0.026	-0.953	1.855*
	(0.837)	(0.816)	(0.821)	(0.830)	(0.812)	(0.825)	(1.324)	(1.063)	(1.044)
Mayor HHI X Royalties Cap				0.063	-0.072	-0.030	0.073	-0.073	-0.031
				(0.148)	(0.126)	(0.252)	(0.153)	(0.121)	(0.252)
Council HHI X Royalties Cap				-0.226	-0.074	-0.189	-0.286	-0.142	-0.157
				(0.305)	(0.197)	(0.248)	(0.306)	(0.195)	(0.264)
Mayor largest party X				-0.067	-0.010	0.048	-0.065	-0.013	0.043
Royalties Cap				(0.050)	(0.032)	(0.056)	(0.049)	(0.031)	(0.057)
Mayor HHI X Revenue Own Cap							0.005	0.038	-0.009
							(0.035)	(0.028)	(0.028)
Council HHI X Revenue Own Cap							0.073	0.093	-0.034
							(0.075)	(0.058)	(0.063)
Mayor largest party X Revenue							-0.005	0.005	0.009
Own Cap							(0.012)	(0.008)	(0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Muni FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Party FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	43279	43279	43272	43279	43279	43272	43279	43279	43272
N Munis	5509	5509	5509	5509	5509	5509	5509	5509	5509
Avg Nr Yrs	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
R-Sq within	0.25	0.43	0.55	0.25	0.43	0.55	0.25	0.43	0.55
R-Sq between	0.88	0.88	0.81	0.88	0.88	0.81	0.89	0.88	0.81
R-Sq overall	0.70	0.71	0.65	0.70	0.71	0.65	0.70	0.71	0.65
Error Structure	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster

* p<0.10; ** p<0.05; *** p<0.01 (two-tailed), Heteroscedasticity robust standard errors in parentheses.

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