Do Oil Windfalls Improve Living Standards? Evidence from Brazil

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Abstract

We use variation in oil output among Brazilian municipalities to investigate the effects of resource windfalls on government behaviour. Oil-rich municipalities experience increases in revenues and report corresponding increases in spending on public goods and services. However, survey data and administrative records indicate that social transfers, public good provision, infrastructure, and household income increase less (if at all) than one might expect given the higher reported spending.

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I. Introduction

Should communities that discover oil in their subsoil or off their coast, rejoice or mourn? Should citizens be thrilled or worried when their governments receive fiscal windfalls? Ample anecdotal evidence on both questions has, over the years, shaken many economists' confidence that the answer is as obvious as it might seem at first brush. Oil, like many other natural resources, has been variously described as a source of "disease" or even, by some, as a "curse," bringing adverse changes in relative prices, corruption, rent seeking, and other ills that result in the dissipation of most possible benefits – if not in extreme cases in an outright decline in living standards. Other types of fiscal windfall, such as international aid or – in the case of local government – transfers from the central government, also often stand accused of creating similar problems.

To provide systematic empirical evidence on some of these issues we study the effects of an offshore oil-induced fiscal windfall among Brazilian municipalities. Offshore oil endowments and production vary widely within Brazil, and we argue that conditional on a few geographic controls this variation is exogenous to municipal characteristics. Furthermore, oil-producing municipalities are entitled to royalties, so we can investigate the consequences of oil-related revenues for the public provision of goods and services and living standards. Because offshore-oil windfalls accrue exclusively to municipalities that are situated on the Atlantic coast, we compare outcomes in offshore-oil endowed municipalities to outcomes in other coastal municipalities.

We begin the paper by documenting that municipal revenues increase significantly with oil production, and that the bulk of this increase is accounted for by royalties. Evidently, royalty payments are not undone by offsetting changes in other transfers from the state or federal governments (or by tax cuts). The revenue-side expansion is matched by a corresponding increase in the expenditure-side of the budget. Municipalities that receive oil windfalls report significant increases in spending on a variety of public goods and services, such as housing and urban infrastructure, education, health, and transportation, and in transfers to households.

Given the significant expansion in reported spending, one would expect sizable improvements in welfare-relevant outcomes for the local population. We therefore look at measures of housing quality and quantity, supply of educational and health inputs, road infrastructure, and welfare receipts. The results paint a complex picture, with no apparent changes in some areas, small improvements in some others, and small worsening in others yet. On balance, however, the data appear to suggest that the actual flow of goods, services, and transfers to the population is not commensurate with the reported spending increases stemming from the windfall, a shortfall that we dub "missing money." To confirm that the windfall does not trickle down to the population through other channels we look at household income, and find only minimal improvements. We also show that oil-rich municipalities did not experience a differential increase in population. This implies that our results are not driven by a dilution of the benefits of oil abundance. Furthermore, the fact that people do not flock to oil-abundant communities reinforces our message that oil abundance has not been seen as particularly beneficial by the population.

Our finding that oil windfalls translate into little improvement in the provision of public goods or the population's living standards raises an important question: where are the oil revenues going? The natural inference is embezzlement. We briefly report some circumstantial evidence for this conjecture and document a number of scandals involving mayors in several of the largest oil producing municipalities, some of which involve large sums of money.

There is a growing empirical literature attempting to provide systematic statistical evidence on the effects of resource abundance and other fiscal windfalls, particularly international aid. The near totality of this work focuses on comparisons between countries.[1] Using variation within Brazil allows us to circumvent some of the well-known limitations of this approach. First, many of the institutional, cultural, and policy variables that potentially confound the cross-country relationship between resources (and aid) and outcomes are held constant, enhancing our ability to make inference. In addition, as we detail below, we can make plausible claims of exogeneity for our measure of resource abundance. This is rarely the case in cross-country work where typically resource abundance is measured in terms of resource exports (an outcome variable). Finally, we are able to focus on one specific channel of causation: the one operating through the change in the amount of public goods and services brought about by the fiscal windfall. Of course, these benefits also imply a limitation: our analysis is silent on other possible channels through which

[1] The "classic" cross-country study on the effect of natural resources is Sachs and Warner (1997), which has spawned a large literature. On foreign aid see, e.g., Rajan and Subramanian (2008) and the references there.

resource abundance affects local socio-economic outcomes. Nevertheless, as we review below, most recent work on natural resources is centered on the way resource windfalls reverberates through the political process, so our focus is germane to an issue that has raised much concern.

A few recent studies have tried, like ours, to move beyond the cross-country correlations and examine resource discoveries using within-country regional variation [Aragon and Rud (2009), Michaels (2011), Naritomi, Soares, and Assuncao (2007), Bobonis and Morrow (2010)]. None of these focus on the fiscal windfall associated with a resource boom. Vicente (2010) compares changes in perceived corruption in Sao Tome (which recently found oil) with Cape Verde (which didn't), and finds large increases in corruption following the oil discovery. On fiscal windfalls, the closest contribution is Litschig's (2008) study of federal transfers to Brazilian municipalities, exploiting discontinuities in the transfer-allocation rule. He finds that these windfalls translate into increased educational spending and gains in schooling.[2]

II. Oil in Brazil: A Brief Overview

Figure 1 presents a summary of the pace and timing of oil discoveries in Brazil.[3] Meaningful onshore oil discovery began in the 1940s, and the number of finds peaked in the 1980s. Successful onshore prospecting activity has since dwindled. Offshore oil prospecting is a much more recent phenomenon, with finds growing rapidly from almost nothing in the early 1970s, to a peak in the 1980s. Subsequently, there has been a marked decline in the 1990s, and a significant pick up in the 2000s – the latter not reflected in the figure because the big finds have occurred very recently. For our purposes, the important take away from the figure is that offshore oil is for all practical purposes a post-1970 development. This is important because later on we

[2] Very recently there have been new contributions by Brollo et al. (2010) exploiting the same discontinuity as Litschig to look at corruption outcomes, and Monteiro and Ferraz (2010) who study the effects of oil royalties on political outcomes (campaign contributions, electoral competition, quality of politicians) in Brazilian municipalities. Other related work is the discovery by Reinikka and Svensson (2004) that the vast majority of public funds due to Ugandan primary schools never reach the intended recipients, which is reminiscent of our "missing money" result, and the "missing imports" finding of Fisman and Wei's (2004). Golden and Picci (2005) also present a related measure based on the difference between physical quantities and prices paid by government. The literature on the effects of transfers from central to local governments is, of course, very large, and to the extent that such transfers represent fiscal windfalls our paper relates to this entire line of research. Much of this literature focuses on the possibility of a "flypaper effect," whereby local public expenditure appears more elastic to federal transfers than to (local) tax revenues [e.g. Hines and Thaler (1995) for a review.]

[3] Throughout the paper we use "oil" as a shorthand for "oil and (natural) gas." Oil accounts for about 90% of the value of output of the oil and gas sector.

show that in 1970 (subsequently) oil-rich municipalities looked indistinguishable from municipalities that did not discover oil later in the century (conditional on appropriate controls).

As of 2005, the Brazilian oil sector accounted for approximately 2% of world oil production, 1% of world oil reserves, and 2% of Brazilian GDP. (All of these figures will rise significantly in years to come). Offshore oil accounts for the vast majority of output. Oil in Brazil is inextricably linked to Petrobras, the oil multinational controlled by the Federal Government, which completely dominates the industry. Given the essentially monopolistic structure of the industry, the oil sector is heavily regulated. The industry regulator is Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP). One of the many important functions of ANP is to oversee the calculation of royalties due on each oilfield, collect the payment, and distribute it to the various recipients. In Unpublished Appendix 1 we give a detailed description of the (very complicated) rules for the allocation of royalties. Here we summarize the main points.

Federal law mandates that Petrobras pay close to 10% of the value of the gross output from its oilfields in the form of royalties. The recipients of royalties include: some federal entities, state governments, and municipal governments, the latter two both directly, and indirectly through the division of a "special fund" into which some of the royalties are paid. Municipal governments are the ultimate beneficiaries of about 30% of the royalty pie, i.e. roughly 3% of the value of gross oil output. This can result in substantial royalty revenues for some municipalities: in the top 25 municipalities by per capita oil output, royalties accounted for about 30% of municipal revenues in 2000.

A municipality's royalty income depends on several factors. Some of these factors are purely geographic, and we discuss them in greater detail below. Other determinants of royalty participation, however, are not geographic. For example, municipalities on whose territory is located infrastructure for the storage and transportation of oil and gas or for the landing of offshore oil, or are even only "affected" by such operations, are also entitled to some. Furthermore, some components of the royalty allocation scheme depend on the size of the municipality's population. For these reasons, royalty income is not a credible exogenous measure of the windfall received by municipalities due to oil. This consideration plays an important role in our identification strategy, which we discuss below.

Another source of "Petro-Reais" for oil-producing municipalities is the "Special Participation" (not to be confused with the "Special Fund" mentioned above), a tax on oilfield output – a royalty in all but name – part of which, once again, is given out to municipalities bearing a close geographic relationship with the corresponding oilfields. The overall value of the "Partecipacao Especial" is similar to the overall value of royalties. For example, in 2004 royalties amounted to R$5735 Millions, while the Partecipacao was R$5995 Millions. However, royalties are more important to producing/facing municipalities, which receive between 20 and 30% of the royalties while municipalities but only about 10% of the "Participacao" [de Oliveira Cruz and Ribeiro (2008), Mendes et al. (2008)].

III. Specification, Data, and Identification

III.A Specification.

Our units of analysis are Brazilian áreas mínimas comparáveis (AMCs), statistical constructs slightly larger than municipalities, for which we have detailed outcome variables (see data section). The main results of the paper are from instrumental variable (IV) estimation of the following model

$$W_m = \delta + \theta\, R_m + \rho\, X_m + u_m, \qquad (1)$$

where W_m is a set of AMC outcomes, including reported spending on various municipal-budget outcomes, real provision of public goods and services, transfers, household income and poverty rates, etc.; R_m, is an AMC-level measure of municipal revenues, and X_m is a set of the following AMC-level geographic controls: latitude, longitude, an indicator for whether the AMC is on the coast, distances from federal and state capitals, a state capital dummy, and state fixed effects.

The set of instruments is $[Q_m\ X_m]$, where Q_m is a measure of AMC-level oil output. In other words we instrument municipal revenues by municipal oil output. The idea behind the instrumental-variable approach is to isolate the average effect of a Real of municipal revenue due to oil (a "Petro-Real"). For this interpretation to be legitimate, we need (i) Q to affect R, and (ii) Q to affect W only through its effect on R. That (i) is the case will be shown in Section V.A, while the case of (ii) is made in Section IV.C. The year in which the variables in (1) are observed varies slightly due to data-availability constraints, but in most cases it is the year 2000.

As a robustness check, we also report results from a first-difference specification:

$$\Delta W_m = \delta + \theta\Delta\, R_m + \rho\, X_m + u_m, \qquad (2)$$

where the instruments are again $[Q_m\ X_m]$. The exact period over which we take first differences in (2) depends on availability of data on outcomes and municipal revenues, but in most cases it is 1991-2000 (i.e. between the last two censuses). Note that we only observe oil output in 1999 (and subsequent years). In instrumenting the change in revenues between two dates by oil output in the final date we are implicitly approximating the change in oil output by the final level. This is not a bad approximation as oil output in the early 1990s was much lower than in 2000, and so were oil prices. In any case this approximation probably only introduces measurement error in the instrument, and is thus not a major concern for identification – as long as the first stage is strong.

While we report the results from (2) for all our outcome variables, in the text we focus on the results for (1). There are three reasons for emphasizing the results in levels. First, as already discussed the instrument is a noisy measure of the change in oil output. Second, there are a few outcome variables for which we do not have baseline outcomes, so we can only run the level regressions. Third, as we discuss below, our data lend themselves more naturally to a test of random assignment of the oil for the level specification. Nevertheless, as the reader will see, the results using levels and first differences are very similar.

As an alternative to specifications (1) and (2), in order to gauge the effects of oil-related revenues, we could have simply regressed the socio-economic outcomes we are interested in on the oil royalties received by AMCs, which we observe. However, as explained above, some of the factors determining a municipality's share in the royalties are not purely geographic, implying that royalty income is potentially endogenous to other municipality-level outcomes. For example, local conditions correlated with our outcomes of interest may also affect whether a municipality hosts oil-transportation infrastructure, or the size of its population, both of which enter the royalty-allocation formula.

III.B Data

Over the decades the number of Brazilian municipalities has increased, as many of them have split into two or more. There is some evidence that some of this splitting was a consequence of perverse incentives in the mechanism that assigns federal transfers to municipalities (transfers per capita are strongly decreasing in population size) [Brandt (2002)]. However, we are not able to rule out that part of this splitting process may have been driven by a desire to game the royalty-allocation system. Furthermore, this fragmentation makes it difficult to test for random assignment of oil at the municipality level, as some of today's municipalities did not exist twenty or more years ago.

To deal with these problems, we work with data at the AMC level. AMCs are constructed by the Instituto de Pesquisa Econômica Aplicada (IPEA), which is the source for much of our data. Each AMC contains one municipality (or more), and the area of each AMC remains relatively stable even when municipality boundaries change. The particular AMC partition we work on essentially reproduces municipality boundaries in 1970, i.e. before the process of offshore-oil discovery. It is therefore immune from the potential endogenous splitting problem. At the same time, since we observe values of the outcome variables in 1970 at the AMC level, we are able to test for random assignment. Altogether, more than 5500 municipalities that exist today are pooled into 3659 AMCs.

As already seen Brazil has both onshore and offshore oil. For reasons we discuss below, it is easier to argue that offshore oil production is exogenous for AMC outcomes than onshore oil production. Therefore, this paper focuses on the effects of offshore oil. The "treated" AMCs, therefore, will be those AMCs that have offshore oil and no onshore oil, as we explain shortly. By definition, treated AMCs are on the coast. In order to focus on a relatively similar control group, therefore, we will compare coastal AMCs with (only) offshore oil with coastal AMCs with no oil (of any kind). All our results, however, are robust to using alternative control groups, such as all non-oil AMCs that are adjacent to our treated AMCs, or indeed all non-oil Brazilian municipalities. We flag at the appropriate points the few occurrences where these results differed.[4]

Many of the variables we use in the paper are directly available from IPEA at the AMC level. Others are available – or must be first constructed – at the municipal level. In these cases we collapse the municipal-level data to the AMC level using a cross-walk from IPEA. Most of the data we use is self-explanatory, so we relegate a detailed discussion of definitions, methods, and sources for most of them to Unpublished Appendix 2 (except for a few notes in the relevant parts of the main text). As a general rule, all variables measured in per-capita terms should be interpreted as the sum of the municipal aggregates divided by the sum of the municipal

[4] Detailed results using all non-oil AMCs, instead of just the coastal ones, as control group are reported in the working paper version [Caselli and Michaels (2009)]. In that paper we also show that the results largely hold for municipalities that have onshore oil, but those results have been omitted here as the exogeneity of the oil windfall is less cleanly established than for offshore oil, as we discuss below.

populations. All dummy variables take the value of one if they take the value of one in at least one of the municipalities in the AMC. Here we only give some of the details of our key instrument, which we constructed (with additional details in the unpublished appendix).

Calculating the value of oil extracted in each AMC involves two steps: (i) build a dataset of oil output for each oilfield; (ii) allocate the oil output of each oilfield among municipalities according to an appropriate rule based on their mutual geographical relationship. Step (i) is relatively easy, as since 1999 ANP reports detailed price and production data for each oilfield. This gives us the value of oil produced each year in each oilfield from 1999 to 2005.

For step (ii) we take advantage of the geographic component of the royalty-allocation formula. As discussed, Petrobras pays royalties (through ANP) for oil extraction to municipal governments, and one component of the royalty allocation formula is based on the principle that a certain percentage of the value of the output of each offshore oilfield must be paid to the "municipalities facing the oilfields." To implement this principle a mechanism had to be devised to determine for each oilfield which are the "facing" municipalities. The principle that has been followed according to Brazilian law apportions the royalties based on the fraction of the oilfield that lies within each municipality's borders' extension on the continental shelf. The resulting percentage allocation is collected in a document called "Percentuais Médios de Confrontação" or average shares of "facing," i.e. shares of each municipality in an offshore oilfield based on the "facing" criterion. We use these shares to allocate oil output from each field to the various municipalities. We then sum over all the municipalities in each AMC and divide by the sum of municipal populations to obtain oil output per capita at the AMC level.

Table 1 present summary statistics from the two key subsamples in our dataset. Column 1 reports figures calculated from the subsample formed by the 156 coastal AMCs that do not have any kind of oilfield, whether onshore or offshore. The second column is based on the subsample of 31 AMCs that have offshore oil, but no onshore oil. As we discussed above, the AMCs with no oil are our "control group," while the municipalities with "offshore only" oil are our "treatment group." All our results, therefore, exclude AMCs with onshore oil.[5] Figure 2 shows a map of Brazil with AMC boundaries and oilfields. Appendix Table A1 reports summary statics

[5] There are 9 coastal AMCs that have both onshore and offshore oil, and 17 that have only onshore oil, so altogether 26 coastal AMCs are dropped from the analysis. In order to establish whether a municipality has onshore oil we combined GIS data on the (terrestrial) boundaries of municipalities, with similar data on the boundaries of onshore oilfields. We then say that an AMC has onshore oil if any of its municipalities is located above (a portion of) an onshore oilfield.

for all the other variables used in our tables.

There are clearly sizable differences in average GDP per capita, municipal revenues and population between oil-rich and oil-poor AMCs.[6] These differences, however, are clearly not causal. For one thing, even among these coastal AMCs, the geographic variables also reported in the table show some systematic differences in the location of oil. To identify the causal effect of oil it is therefore important to control for these additional geographic characteristics. We also control for state fixed effects.

The table also reports statistics from the distribution of our constructed measure of oil output per capita.[7] It is important to keep in mind that our oil output measure corresponds to a gross output concept, so it is not directly comparable to the GDP numbers in the table. Nevertheless the following back-of-the-envelope calculation can be used to get a sense of the importance of oil in oil-rich municipalities. In the national accounts, value added in the oil sector is about 40% of gross output. Applying that percent to the average gross output number in Table 1 we find that oil accounts for almost 20% of GDP in the offshore-only oil AMCs. Another important message from Table 1 is that there is massive variation in oil output within oil-rich subsamples, with the 90th, 95th , and 100th percentiles all being large multiples of the mean. This underscores that our identification of the effects of oil comes as much from within oil-rich variation as from variation between the no-oil and the oil-rich samples.

Admittedly, our group of offshore-oil producers is quite a small sample, and the results are bound to depend on variation among a handful of AMCs. For example, the top two AMCs ranked by oil output per capita are critical to identify the effect of oil abundance on revenues, as can be seen from the scatterplot in Appendix Figure A1.[8] While this is obviously not a problem conceptually (that's where the variation is!), it is perhaps useful to note that all the main conclusions of the paper go through when using the full sample with all oil-producing AMCs, i.e. including onshore-oil producers (where the results are extremely robust to taking out subsets as

[6] To convert R$2000 to 2008 US dollars the appropriate conversion factor is roughly 1. Our reason for reporting GDP for 2002 (instead of 2000 as for the other variables) is discussed later.

[7] We should point out that there are a few cases of zero oil output even among the "oil AMCs." This is because the oil-AMC dummy is constructed based on having a positive share in an oilfield that was operating in 2007 (see Appendix 2). Some of these fields were still in the development stage (or still undiscovered) in 2000.

[8] The top two AMCs by oil output include the municipalities of Rio das Ostras, Casimiro de Abreu, Macaé, Quissamã, and Carapebus, all of which are well-known large royalty recipients. When they are simultaneously omitted from the offshore-only sample, the point estimates do not change very much but the standard errors increase massively. When AMCs are dropped one at a time all the results in the paper are robust.

large as the 10 top AMCs, again as measured by oil output per capita). These results are reported in detail in the working-paper version.

III.C Identification

We begin the discussion of our identification assumptions by arguing that Q_m is exogenous to local characteristics and local shocks. We start this argument by showing that a number of municipal-level outcomes did not differ in oil-rich and oil-poor AMCs *before oil was discovered.* As we have just seen, oil and non-oil AMCs differ somewhat in a number of geographical characteristics. This means that oil is potentially spuriously correlated with other covariates. But our claim is that oil is as good as randomly assigned *conditional on geographic covariates* (state fixed effects, longitude, latitude, distance to federal capital, distance to state capital, state-capital dummies, and coastal dummies). In other words, once we compare oil and non-oil AMCs with similar geographic characteristics, oil-abundance is random.

To establish conditional random assignment we relate pre-discovery socio-economic outcomes to *subsequent* oil abundance, as measured by oil output in 2000. Table 2 shows results from cross-sectional regressions of the following form

$$Y_{m,1970} = \delta + \eta\, Q_{m,2000} + \theta\, X_m + w_m, \qquad (3)$$

where $Y_{m,1970}$ is a socio-economic outcome in AMC m in 1970, and $Q_{m,2000}$ is oil output per capita in AMC m in the year 2000.

Our main reason for focusing on 1970 for our falsification test is that going back before 1970 would significantly reduce the number of AMCs, due to boundary changes during and before the 1960s. In addition, for some of the outcomes (particularly those related to housing – an important variable for us) the data are not available before 1970, irrespective of the level of AMC aggregation. On the other hand, nearly all of the offshore discoveries were made after 1970, so not much is lost by not presenting results for the pre-1970 period.

It is quite clear that most socio-economic outcomes in 1970 do not vary systematically with the quantity of oil that will later be produced in coastal AMCs. This is true for years of schooling, literacy rates, residential capital stocks, electricity connections, sewage and drinking water (again, we discuss these variables in more detail below). The only exception is GDP per capita, which is slightly lower in oil-rich-to-be AMCs in the OLS specification.[9] In order to check for the overall significance of these outcomes differences in the last column of the table we perform a "family-of-outcomes" test (Leibman et al. 2007 and Beaman et al. 2009), which is insignificant This is strongly indicative that, conditional on our covariates, AMCs did not differ from each other in a way that was correlated with their subsequent oil production.Table 2 shows that conditional on the geographic covariates, oil output per capita in 2000 is generally uncorrelated with various socio-economic outcomes in 1970. This in itself goes a long way in providing support for the identification of models (1) and (2). However, even if initial conditions were invariant to the oil abundance (and to 2000 oil output), one could in principle still be concerned that among oil AMCs the quantity of oil extracted, say, in 2000 is endogenous to other AMC-level shocks occurring after discovery. Similarly, one could be concerned that prospecting decisions and discovery events after 1970 could have been influenced by shocks occurring after 1970.

We argue that this is implausible. Oilfield operations in Brazil over the sample period were carried out by Petrobras, a global hydrocarbon giant with access to global factor and product markets. Neither its highly specialized equipment, nor its equally-specialized labor force could realistically be expected to be drawn locally, so local factor prices should not be a consideration. The oil fields are operated through gigantic rigs located many miles away from the coast, and hence from the municipalities that receive the revenue windfall. These rigs are supplied by large ships (and helicopters) that travel to/from a handful of large ports, typically pre-dating the oil discoveries, and certainly not necessarily from the "facing" municipalities that receive the royalties. Production may vary over time due to fluctuations in oil prices and/or in the prices of some inputs, but none of the inputs are sourced from the "facing" municipalities. At a point in time, variation across municipalities in our measure of oil output must be overwhelmingly driven by the size of the oilfield, the technical difficulty of extracting the oil in that particular location, and the share of the oilfield that is "captured" by the continental-shelf extension of the municipal boundaries.

Another possible concern is that municipalities compete to lobby and/or bribe Petrobras to drill near them, or to influence the amount of oil extracted in a given location. However, municipalities are tiny and do not have the political heft and financial resources to sway the decisions of Petrobras, one of the World's biggest companies. It is interesting in this respect that

[9] The coefficient estimate implies that for every peso worth of oil extracted in 2000 the AMC's 1970 GDP was lower by 3 cents. The construction of the GDP numbers (both aggregate and sectoral) appears to be based mainly on firm- and consumer surveys as well as on tax returns. A description of the principles underlying the construction of these numbers can be found in IBGE (2008).

in a regression predicting oil output in 2000 with longitude, latitude, coast dummy, distances from state and federal capital, and a state-capital dummy (and state fixed effects) distance from state capital has a significant positive coefficient (p-value 0.04) while the state-capital dummy has a (borderline significant) *negative* coefficient (p-value 0.11) – a result that is hardly consistent with the view that oil output is affected by political influence (distance from federal capital is insignificant. Results available on request).[10] Second, unlike many Brazilian institutions, Petrobras actually has a strong record and reputation for integrity – at least in recent years. This record has been explicitly recognized by international NGOs operating in the natural-resource area, e.g. Transparency International (2008).

Even if oil deposits are randomly assigned, and oil production is exogenous to local considerations, we still need to argue that oil output affects outcomes of interest (mainly spending by the local government, provision of public goods, services, and transfers, and household income) only through the revenues it generates for the municipality. Support for this claim is based on showing that oil production has little or no effect on non-oil economic activity, as measured by non-oil GDP. To show this, we present in Table 3 results from the following specification

$$Y_{m,2002} = \delta + \eta\, Q_{m,2002} + \theta\, X_m + w_m, \tag{4}$$

where $Y_{m,2002}$ is GDP in 2002, $Q_{m,2002}$ is oil output in the same year, and X_m is the usual set of geographic controls.[11]

In interpreting the coefficients in Table 3 it is important to recall that the right-hand-side variable, oil output, is a measure of *gross output*, while the left-hand-side, municipal GDP, is a measure of *value-added*. Consider what this implies, for example, for the regression in column 1,

[10] One issue that is definitely not a concern is the positioning of oil rigs conditional on exploitation of a certain oil field. Suppose that Petrobras can choose to pump oil out of an oilfield that "belongs" (according to the confrontacao formula) to two different AMCs. In this case it does not matter whether Petrobras pumps out the oil from the part of the field that belongs to one AMC or the other. Either way the AMCs will get the same share of the oil.

[11] We estimate (4) for the year 2002 because our measure of GDP in oil-abundant municipalities experiences a dramatic discrete drop between 2001 and 2002. An investigation of the data-construction measures behind the IPEA figures reveals that up to 2001 inputs into oil extraction were misattributed to the AMC where operations headquarters were located, rather than – correctly – to the AMC were the extraction took place. This mistake resulted in a vast overestimate of oil GDP at the AMC level, because it essentially amounted to using gross oil output to measure oil GDP. Needless to say, the overestimate of oil GDP carried over to aggregate AMC GDP, which was thus also grossly overestimated. The year 2002 is the first year for which this mistake was removed. This mismeasurement does not invalidate the falsification exercise we conducted in Table 2. The point of that exercise was to show that differences among municipalities were not systematically related to oil abundance before (and for several years after) the oil discoveries. Inflation in oil GDP numbers in oil-rich municipalities would only work against our case, by tending to make the effect of oil to seem to "kick-in" earlier than it did.

where the dependent variable is aggregate AMC GDP and the coefficient on oil output is approximately 0.4. Because aggregate GDP is the sum of oil and non-oil GDP, R$0.4 is the sum of the direct effect of R$1 worth of oil extracted on oil GDP and its indirect (or spillover) effect on non-oil GDP. Now as already mentioned at the *national* level the share of oil GDP in gross oil output is also fairly stable and around 0.4. Under fairly standard assumptions average and marginal shares of GDP in gross output are the same, so to the extent that the national numbers are representative of local production relations the results in column 1 are *prima facie* evidence that oil production has little if any (positive or negative) spillovers on non-oil economic activity.[12]

We also have AMC-level GDP numbers disaggregated into industrial (manufacturing, construction, extraction industries, and utilities) and non-industrial (agriculture, government, and services) GDP. In columns 2 and 3 we look at the effects of gross oil extraction on these two subaggregates. Since oil GDP is part of industrial GDP, column 2 has much the same interpretation as column 1, and since coefficients are still stable and close to 0.4 they suggest that in the typical oil-rich AMC oil production has little if any spillovers on other industrial subsectors. Similarly, column 3 shows essentially no spillovers from oil to the service sector. This last result is important because in this case the no-spillover conclusion does not rest on an (admittedly uncertain) estimate of the share of oil GDP in gross oil output, as is the case for aggregate GDP or industrial GDP. Hence, for AMCs with offshore oil only, oil seems to have no *market* effects on economic activity. We infer that any effect from oil likely arises from the revenues it brings to the municipal government, making this the ideal control group to study the effects of oil-related fiscal windfalls on the provision of public goods and services.[13]

One last issue relevant to identification is the role of population flows. Since our outcome variables are per capita, and since for many of the outcomes we tend to find little if any positive

[12] In formulas, begin by the identity GDP = NON-OIL GDP + OIL GDP. From column 1 we have d(NON-OIL GDP)/d(Gross oil output) + d(OIL GDP)/d(Gross oil output) $\approx$ 0.4. From data at the national level d(OIL GDP)/d(Gross oil output) $\approx$ 0.4 So that d(NON-OIL GDP)/d(Gross oil output) $\approx$ 0. Needless to say, it would have been cleaner to simply obtain a measure of non-oil GDP and regress it on oil output. Regrettably, despite numerous attempts, we have been unable to obtain the figures used by IBGE for oil GDP, so we cannot net it out of aggregate GDP to obtain non-oil GDP. We do know that oil GDP at the municipal level is computed by distributing Petrobras value added according to a geographical formula similar to the one used by ANP to allocate (the geographical component of) royalties to municipalities [IBGE (2008) and e-mail exchanges with IBGE staff].

[13] In results reported in the working-paper version of this paper, we found some evidence that onshore oil changes somewhat the composition of non-oil GDP: industrial value added drops slightly, while non-industry value added increases. These results are one of the reasons why in this paper we focus on the AMCs with offshore oil only as our treatment group.

welfare effect from oil abundance, one possible concern is that oil discoveries in a certain locale attract migratory flows which dilute the benefits on a per-capita basis. Appendix Table A2 shows that there is no significant effect of oil on population, so our conclusions below are probably not driven by changes in the denominator. Moreover, the fact that people do not flock to oil-rich municipalities foreshadows the main result we discuss in the next section, namely that the benefits of oil windfalls to the population at large are limited.

IV. Results

IV.A Oil Abundance and the Local Government Budget - Revenues

We begin by confirming that oil brings revenues to Brazilian municipalities. Column 1 of Table 4 focuses on the cross-sectional relation between oil output and revenues in the year 2000. The coefficient implies that one Real of gross oil output increases total local-government revenues by almost exactly 3 cents.[14] One shortcoming of the results in column 1 is that there are missing values for municipal revenue in 2000 for about 18 percent of the AMCs. In column 2 we use 2001 values to impute the missing observations for 2000 (so we are now missing only about 6 percent of AMCs), with no change in results.

In column 3 we investigate the sources of the increase in revenues, by looking at the effect of oil production on royalty income. The increase in royalty income accounts for 53% of the overall increase in municipality income due to oil production. The bulk of the remaining 47% is almost-certainly accounted for by the "Special Participation," discussed in Section II.

Column 4 shows a specification in semi-differences, i.e. with the 1991-2000 change in revenues regressed on 2000 oil output – which, for reasons discussed above, is also a reasonable proxy for the change in oil output. The coefficient is very close to the coefficient in the level regression for 2000. Note that column 2 is essentially the first stage for our main IV estimates of specification (1), and column 4 is the first stage for specification (2).

One implication of Table 4 is that the money received from oil operations is not offset by a reduction in federal government transfers to the local government. Indeed, the fact that the increase in revenues is larger than the royalties suggests that there is not even a partial offset. Similarly, since revenues increase substantially, it does not seem that municipal governments

[14] Throughout the paper we use "cent" for "Centavos," or one hundredth of a Real.

take advantage of royalty income to cut local taxes.[15]

IV.B Oil Abundance and the Local Government Budget - Spending

So oil brings money to the local government. What does the local government do with it? We begin in Table 5 with what the local government says it does, by looking at the effect of oil on *reported* spending. To establish a baseline, the first row of the top panel shows simple OLS regressions of spending on some of the functions that account for the largest shares of the average municipality budget on total revenues. The most important items are Education and Culture, on which municipalities report spending about 22 cents of each Real that comes into their coffers, and Health and Sanitation and Housing and Urban Development, each of which receives about 10 cents on the Real. Transportation and Transfers to Households also receive significant shares of spending by function.[16] Overall, total reported spending accounts for about 80 cents of every Real of revenue, consistent with the fact that Brazilian aggregate municipal statistics show a surplus for 2000.

The OLS results, here and in the following tables, do not necessarily identify a causal effect, as municipal revenues are potentially endogenous to reported municipal spending. Such a bias, if present, would be likely to be positive, as municipalities that report larger spending will need to attract more federal transfers and/or raise more taxes. Even if they could be interpreted causally, the OLS coefficients would describe the allocation of revenue independent of its source, not the effect of oil-related revenues.[17]

In order to causally identify the reported utilization of oil-related revenues, in Panel B we turn to our empirical model (1), where municipal revenues are instrumented for by oil output. In other words, we treat the regressions in Table 4 as first-stage regressions in a two-stage least-

[15] And as we would expect, a regression of local tax revenues per capita on municipal revenues per capita, instrumented as usual by oil output per capita (with all variables measured in 2000), and with our usual controls, yields a coefficient of -.035 with a standard error of .031.

[16] Education spending by municipal governments is mostly in the area of primary schooling. Health spending includes local clinics and hospitals. Housing comprises the planning, development and construction of housing in both rural and urban areas. Urban Development includes urban infrastructure. Transfers to households include "Social Assistance" (to the aged, to the handicapped, to children and communities) and "Social Security." We do not have the year 2000 breakdown of these two items but in 2004 (and subsequently) the latter accounted for about 2/3 of the total. Nevertheless, social security is probably fairly tightly linked to retirement patterns, and hence to the demographic structure of the AMC's population. Hence, we conjecture that social assistance is more discretionary and hence the relevant component at the margin.

[17] Another possible source of bias is measurement error, but this is unlikely to be a major issue, as we are using administrative data.

square estimation of the effect of increases in revenues on spending. Our IV results show that the largest reported beneficiary of the increase in government revenues from oil is Housing and Urban Development, with about 18 cents of the marginal "oil Real." Education and Transportation share second place, with, respectively, 14 and 13 cents. Health receives about 10 cents, and Transfers to households 5 cents.

Note that the differences between the IV and OLS results are neither statistically significant nor systematic: sometimes the OLS coefficients are larger, and sometimes they are smaller. Importantly, however, the coefficient on total spending is very similar. As discussed above, endogeneity bias would lead us to expect the OLS coefficients to be systematically larger than the IV ones, especially for total spending. Hence, we are somewhat inclined to favor a causal interpretation of the OLS coefficients. Under this interpretation, differences in OLS and IV results capture differences in in the effects of general revenues vs. oil-related revenues. We return to this distinction in the discussion at the end of the paper.

IV.C. Oil Abundance and Public-Service Provision

Table 5 shows that oil-related revenues feed increased reported spending on housing and urban services, transportation, education, health, sanitation, and transfers to households. The purpose of this section is to look at a variety of measures of real outcomes in all of these areas, to see to what extent the increased reported spending leads to material improvements in living standards.

Table 6 looks at a variety of housing, urban service and infrastructure outcomes: overall value of the residential housing stock, a proxy for housing quantity (rooms per person) and measures of quality of housing and infrastructure, namely the fraction of the population living in favelas, connection to electricity, water and sewage networks, piping, garbage collection, and extent of roads under municipal jurisdiction. All these variables bar roads are constructed from the micro-data of the Brazilian household census (Censo Demográfico).[18] The length of roads under municipal jurisdiction is constructed by us from administrative records.

Our focal IV results in levels for individual outcomes are statistically indistinguishable from

[18] Residential-capital values are based on Census data on housing characteristics and location, which are then converted into Reais through a hedonic model. The number of rooms is the total number of rooms, not just bedrooms. We also note for readers unfamiliar with Brazilian data that the Brazilian "census" is really a representative sample covering approximately 12% of the population.

0 at standard confidence levels in five cases. Of the remaining outcomes, the percent of people not living in favelas and the kilometers of paved roads have statistically significantly *negative* coefficients, at the 5% and 10% level, respectively. Only the fraction of households that benefit from garbage collection appear to be positively affected by oil revenues. When we look at the "family out outcomes" we get a significantly negative effect, indicating that, overall, oil-related revenues destroy public good and service provision. As seen from panel D, these estimates in levels appear to be a best-case scenario for the effects of oil: in first differences the coefficient on garbage collection turns from positive to significantly negative, and the coefficient on households with sewage connection turns from insignificant to significantly negative.

In Table 7 we look at actual inputs into education (number of teachers and of classrooms, both in 2000 and 2005) and health (hospitals and clinics in 2002), and certain transfers received by households in 2000 (these include transfers for the alleviation of poverty, unemployment benefits, and incentives for schooling for poor families).[19]

The results on education are slightly more encouraging than those for housing and road networks. While there is no statistically significant effect on outcomes in 2000 (columns 1 and 2), in our benchmark IV specification in levels larger oil-related revenues appear to be associated with increases in municipal teachers and classrooms in 2005 (columns 3 and 4). The point estimate implies that a million Reais of extra revenue in 2000 is associated with the hiring of 3 teachers and the construction of 2 classrooms in 2005. There may therefore be some real benefits from oil in the sphere of education, though unfortunately as can be seen from panel D these results are not robust to first differencing.

In columns 5 and 6 we look at municipal health infrastructure. In our benchmark level-IV specification there is no statistically significant effect on either hospitals (column 5), or clinics (column 6), though the coefficient on the latter turns positive in first differences.

Finally, in column 7 we look at the effect of oil-related revenues on poverty- and unemployment-related social transfers from the population census. Since we have no baseline we have the level effect only. There is no indication that these welfare-like payments increase with oil revenues (the pint estimate is actually negative).

Overall, we estimate a statistically positive "family of outcome" effect, which is clearly

[19] For the first-difference specification we use 1992 and 1996 as our base years for health and education variables since those are the earliest years for which we have outcomes comparable to those in our later year of data.

driven by the education outcomes (though only in the specifications in levels). In other areas, the reported spending of the oil revenues continues to appear to have gone missing.

Taken together, the results from Tables 5, 6 and 7 are potentially troubling. Reported spending on housing, transportation, education, health, and social transfers all respond strongly to revenues from oil, but when we look at indicators of real outcomes in these areas we find effects that seem extremely small compared to the reported budget items. The possible exceptions are in garbage collection and education, where some benefits from oil do appear to materialize.

IV.D Limitations of the Results on Public Service Provisions

We now discuss two important issues concerning the conclusions we have just drawn.

(i) *Time to build.* A possible concern with our results is that we fail to identify positive effects because spending produces benefits only with some lag. For example some of the spending is directed at infrastructure projects and these may take a few years to complete. The comparison between columns 1-2 and 3-4 of Table 7 lends some credence to this view, where outcomes seem to respond more strongly when a lag is allowed for. In assessing the importance of this concern a number of considerations are relevant. First, only some of our outcome variables are plausibly subject to "time to build." In particular, there is no great delay needed to hire teachers or mail transfer payments to households. Second, there is no effect whatever of spending in 2000 on municipal roads in 2005, even though transportation is one of the significant winners from oil revenues in the reported spending. If anything the effect is negative.

Third, it is important to keep in mind that municipal revenues from oil are persistent over time. AMCs with relatively large revenues in 2000 tend to have had relatively large revenues for several years, so our coefficients should not necessarily be interpreted as measuring the impact effect of contemporaneous revenues. Rather, they should be thought of as capturing the cumulated effects of several-year worth of Petro-Reais. To make this point more concrete, in Appendix 1 we present an attempt to estimate cumulative municipal revenues since 1991 associated with one Real worth of oil production in 2000. In performing this calculation we make conservative assumptions, and our estimates are almost certainly downward biased. Still, we find this lower bound to be in the order of at least 6 cents, namely double the "flow" coefficient for 2000 we reported in Table 4. This confirms that municipalities receiving oil-related revenues in

2000 had been doing so in previous years as well.

(ii) *Crowding out of state and federal spending.* The items in the state and federal functional spending budget are essentially the same as in the municipal budget, and the "division of labor" between different levels of government in Brazil is blurred. It is therefore conceivable that state and federal bodies withdraw funding in areas where they are aware of increased spending by municipal governments. We can rule out this concern in the areas of education, health, and transportation, because our road, teacher, classroom, and health establishment variables explicitly refer to provision by municipal governments only. They are therefore net of state and federal contributions, and as such not subject to crowding out.[20]

Still, it is interesting to see if federal and state provision in these areas responds to municipal oil revenues. We investigate this question in appendix Table A3, and we find that state- and federally-provided goods and services are generally unaffected by oil-related municipal revenues.[21] In the same table we also show that there is no crowding out in the value of federal contracts, which are individually negotiated deals between the mayor and the federal government to finance specific projects.[22]

IV.E. Oil Abundance and Household Income

The results so far generate some questions as to the extent to which the reported spending increases actually materialize in services to the population. Nevertheless, it is still conceivable that the population benefits from the government's expansion of the budget in ways that are not directly captured by our indicators of public-good provision. Hence, in Table 8 we study the effect of oil-induced government revenue on a summary measure of living standards: namely household income per capita, which we compute from the Brazilian census.

Column (1) shows that there is no significant effect on average household income whatever in the IV regressions. These results suggest that the reported expansion in the government budget

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[20] There are federal and state transfers to municipalities earmarked for education, health, and road construction, but crucially these transfers show up as revenues in the municipal budget, as well as spending items in the corresponding functional categories (we have confirmed this in private communications with a Brazilian fiscal expert). But now recall that we observe both revenues and reported spending increasing with oil, so crowding out of these transfers cannot be the explanation for our results.

[21] The only exception is that oil output decreases the change in federal and state clinics per capita, but even this change is not significant in our main (cross-section) specification. Litschig (2008) also looks at whether fiscal windfalls due to discontinuities in the allocation formula for federal transfers crowd out other sources of revenues, and finds no evidence of this.

[22] We are grateful to Fred Finan for alerting us of this issue and making this data available to us.

has not lead to aggregate increases in living standards that we have somehow missed in the previous section.[23] In the next five columns we look at the effect of oil on average income within each quintile of the household income distribution. This gives a somewhat more nuanced view than looking at the average effect. In particular, we do find some evidence that household income increases in the bottom quintile of the income distribution.[24] Nevertheless, it is important to notice that these increases are small: for every per-capita Real of increased revenue (and spending), the increase in income is in the order of ten cents. To benchmark this number, consider this: suppose the government mechanically rebated each Real of oil-related income to all households in the municipality equally (and there were no additional general equilibrium effects). Then *all five* of the coefficients in columns (2)-(6) should *simultaneously* be 1. In the last column of Table 8 we look at the effect of oil on poverty rates. In levels, there is no statistical evidence of a decline in poverty associated with extra oil-related revenues.[25]

V. Interpretation and Discussion

Our results suggest that some of the revenues from oil disappear before turning into the real goods and services they are supposed to be used for. Where is this missing money going?

The decision on how to allocate oil revenues rests with the agent, or group of agents, with executive control over the windfall. In the context of Brazilian municipalities this tends to be the group formed by the Mayor and his or her close associates (including some members of the local legislature). In allocating this revenue, the Mayor and his associates have essentially three broad options.[26] The first category is the provision of public goods and services. The second category may be termed "unproductive self-preservation," and covers activities the Mayor engages in with

[23] Note that there is no contradiction between the positive coefficients on GDP per capita, an output measure, in Table 3 and the zero coefficient on average income in Table 8. In an open economy output and income can be very different as factor payments may flow to agents residing outside the municipality. In this particular case, the value added of the oilfields is distributed to rig workers (typically international highly-skilled professionals residing in major Brazilian metropolitan areas, if not abroad), and to the shareholders of Petrobras, an equally international group.
[24] At the 10% significance level in the specification in levels and at the 5% level in the specification in changes.
[25] There is a significant reduction in poverty in the first-difference specification, though the point estimate implies minuscule effects. Municipal revenues due to oil need to increase by 100 Reais *per capita* to see a reduction in poverty of 0.67 of one percentage point. This is more than the average revenue from oil royalties in the oil abundant sample (see Table 1).
[26] The working paper presents a simple formal model of the Mayor's decision problem. See also Caselli and Cunningham (2009).

the sole goal of improving his chances of re-election. These include everything from creating fictitious "patronage" jobs, where the "workers" receive wages without delivering the corresponding (meaningful) amount of labour services, in exchange for votes at a future election, stealing the funds and use them to buy votes, using the funds to get the media to provide favorable coverage, etc.[27] The third allocation option is simply to use the money to enrich themselves.[28] Our "missing money" results suggest that the Mayor's group choose to allocate most of the oil windfall to the latter two uses, namely political self-preservation and personal enrichment.

In order to achieve this diversion of funds the group around the Mayor could use various techniques. To create patronage jobs they will simply increase "official" public employment by giving jobs to political supporters. And in order to recycle public money into private funds to be used for vote buying or self-enrichment the Mayor can award fictitious public-procurement contracts to close associates who will then rebate (most of) the money back to him.

In order to provide some support for this interpretation, in the working-paper version we show suggestive evidence that oil-related revenue increases the quality of housing for municipal workers – but, as we already know, not for everyone else. We also show that mayors of municipalities that produce large absolute amounts of oil are more likely to be quoted in the news media in stories involving corruption, and to be investigated for corruption by the federal police. This evidence is circumstantial, but it is not inconsistent with the view that embezzlement accounts for the missing money.

As an informal check on the nature of the allegations behind news stories and federal police operations, we made a broader search of the news on the 10 most oil-rich municipalities (by oil output in 2000). Some of the stories are summarized in Appendix Table A4, and they appear to indicate that corruption in oil-rich municipalities is a serious concern. One of the stories relates to "Operação Telhado De Vidro" ("Operation Glass Ceiling") in the municipality of Campos dos Goytacazes, the largest oil producer in 2000. In March 2008, a large number of local-government

[27] See Robinson, Torvik, and Verdier (2002), and Acemoglu, Robinson, and Verdier (2004), for models emphasizing patronage as a source of votes for the incumbent. Increased self-preservation spending may not be just due to more resources available for the purpose. It could also be that the presence of a windfall increases competition for top municipal jobs, forcing incumbents to divert and spend more. Contributions emphasizing increased power struggles following resource windfalls include Tornell and Lane (1999), Ross (2001a, 2001b, 2006), Mehlum, Moene and Torvik (2006a, 2006b), and Caselli and Coleman (2008).

[28] In principle there are other possible categories, such as lowering taxes and increasing municipal saving, but our results show that neither is very relevant in the Brazilian municipal context.

officials at the highest level were accused of diverting the equivalent of 140 million dollars. This is larger than the average municipality's annual budget, though still only a fraction of the royalties received by Campos dos Goytacazes over the past decade.

A more benign interpretation of our results might be that the Mayor simply shares the rents from the oil revenues by simply rising municipal workers' wages (which would account for the increase reported spending) without expecting of them higher productivity. When we look at average municipal wages, however, we find no change in response to increased oil-related income (results available on request). Hence, the embezzlement interpretation appears more consistent with the data.

A particularly important question for future research is whether and to what extent the implications of fiscal windfalls from natural resources are different from other types of windfalls, such as foreign aid or federal transfers, and – if so – why.[29] Our results on health, education and household income tend to paint to a more beneficial picture of the uses of general revenues relative to oil-related revenues, as the OLS coefficients are almost uniformly larger than the IV ones (Tables 7 and 8). This suggests that oil-related revenues tend to go missing more easily than general revenues. One caveat to this conclusion is that general revenues appear to be as ineffective as oil revenues in the area of infrastructure and housing (Table 6).[30]

Should there be a systematic difference in the effects of natural-resource based revenues vis-à-vis other types of fiscal revenues we think the most likely explanation would have to do with voter ignorance. Observing and estimating royalty income may be harder than forming an idea of the likely magnitude of other types of incomes.[31] There is some circumstantial evidence that the general public is ill informed about the magnitude of the oil-related fiscal windfall. In Campos dos Goytacazes, mentioned above as the largest oil producer of Brazil, the local news bulletin "Petróleo, Royalties & Região" conducted surveys to assess the local population's knowledge about oil royalties. In May 2004 respondents chose a range of values for the monthly fiscal receipts due to oil. 66% of respondents underestimated, i.e. picked a range below the "correct"

[29] Dalgaard and Olsson (2008) argue with cross-country data that resources corrupt more than aid.
[30] Another caveat, as already discussed, is that the larger OLS coefficients may reflect endogeneity bias, though recall that the results in Table 5 provide some circumstantial support for a causal interpretation.
[31] Of course this does not imply that other types of income are observed perfectly, nor that there should be zero corruption from other sources. Indeed Brollo et al. (2010) also explain their finding that federal transfers increase corruption with imperfect information of voters.

interval of R$20m to R$50m. Only 15% overestimated.[32]

[32]http://www.royaltiesdopetroleo.ucam-campos.br/index.php?cod=1. Incidentally this quarterly bulletin is a very interesting window on the concerns raised locally by the oil windfall. Recurrent themes are the lack of transparency in the utilization of the royalties, and the perceived ineffectiveness of royalty money in promoting development and living standards. The September 2004 issue pointedly reports that one year of royalty money would be enough to build 18,890 social housing units (casa populares) *or pay for a presidential election campaign*.

VI. Conclusions

Oil production generates significant increases in municipal revenues. These windfalls are matched by reported spending increases, particularly in urban infrastructure and housing, education, health services, and transfers. However, improvements in various areas of public-service provision appear small compared to the corresponding reported spending increases. Furthermore, increases in household income are modest-to-undetectable. There is suggestive evidence that some of the "missing money" is accounted for by embezzlement.

These findings suggest that incumbent Mayors are able to divert the majority of the oil revenues that accrue to the municipality. The diverted funds may be allocated to a combination of self-enrichment and vote buying.

Specific to the Brazilian context, our findings may imply that oil-rich municipalities should be given special consideration in the current trend towards greater decentralization (Lipscomb and Mobarak 2007) and in the design of audit schemes aimed at curbing corruption (Ferraz and Finan 2008a, 2008b). This special focus may become even more important following the recent discovery of huge new offshore fields. Indeed, the issue is of massive current political relevance, as the government has recently proposed a radical reform of the royalty regime, creating a major political faultline in national politics.

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Figure 1. Number of Oilfields Discovered by Decade

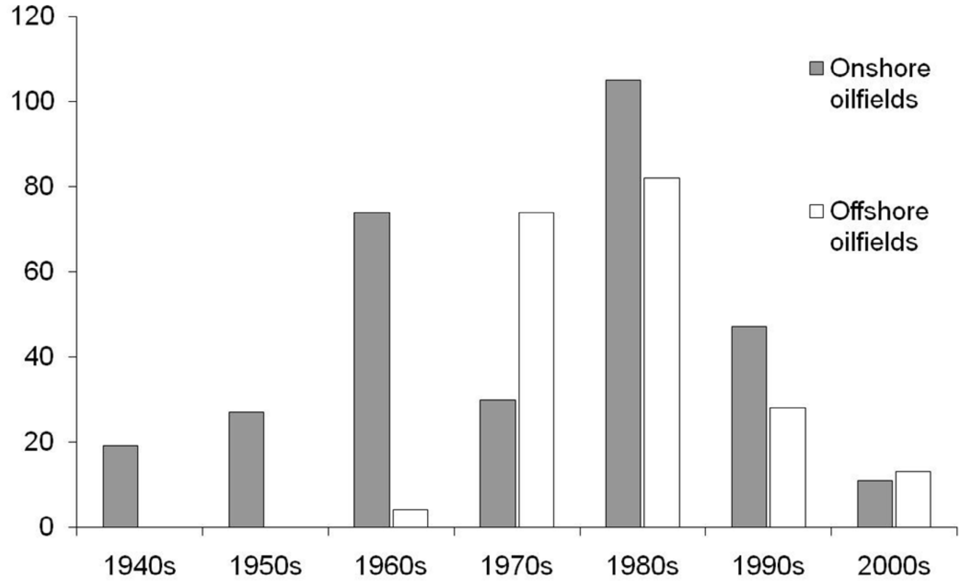
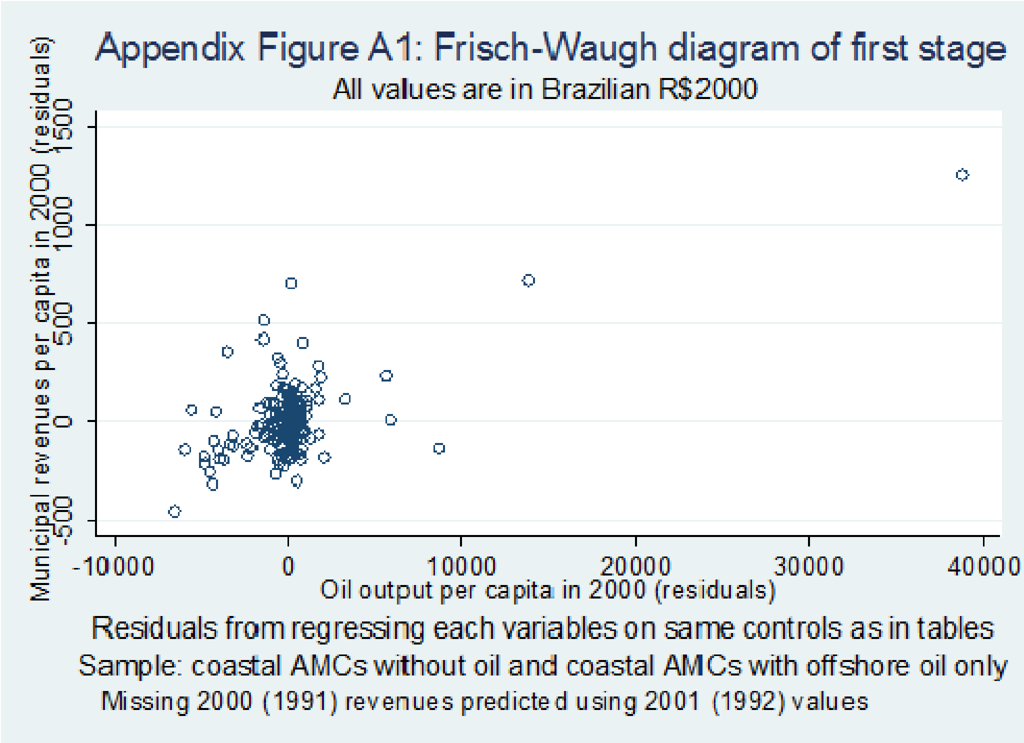


Figure 2. AMCs (from 1970) and Oilfields in Brazil

Appendix 1: A Rough estimate of cumulative oil-related revenues over the 1990s.

In order to estimate the cumulative revenues associated with oil production in 2000 we run a set of regressions of municipal revenues in each preceding year on oil output in 2000. We have done this already in Table 4 for 1991 and 2000, but we repeat this for every intervening year. The cumulative effect of one Real of oil in 2000 on revenues between 1991 and 2000 should be the sum of all these coefficients. The results are in Unpublished Appendix 3. Unfortunately, the municipal-level data on total revenues suffer from unacceptably high numbers of missing values in 1998 and 1999. In each of these two years, 25% of the AMCs in the offshore oil sample fail to report municipal revenues, so we can't put any store on the coefficients from these two years. We do have, separately, municipal royalties in 1999 (with no missing values). Hence, as a partial remedy to the "hole" for that year we can regress 1999 royalties on 2000 oil output. We get a coefficient of 0.0100 (s.e. 0.0013). To construct a lower-bound estimate of cumulative revenues between 1991 and 2000 we do the following (i) sum over the *statistically significant* coefficients of revenues on 2000 output (these are 1991-1995, and 2000); (ii) add 0.01 for 1999 from the royalty regression. This gives 0.0638, i.e. roughly double the flow estimate for 2000.

It is important to highlight the reasons why this is a lower bound. First, we have treated the two insignificant estimates in 1996 and 1997 as zeros, even though at least the 1996 figure is borderline significant. Second, we have assumed a zero coefficient for 1998, just because the sample size is too small for revenues and we have no royalty data at the municipal level. Third, we have used the coefficients for royalties in 1999, but recall from Table 4 that in 2000 the coefficient on royalties is only about two-thirds than the coefficient on total revenues.



Appendix Figure A1: Frisch-Waugh diagram of first stage

All values are in Brazilian R$2000

Residuals from regressing each variables on same controls as in tables
Sample: coastal AMCs without oil and coastal AMCs with offshore oil only
Missing 2000 (1991) revenues predicted using 2001 (1992) values

Table 1. Summary Statistics for Brazilian AMCs

	(1) Coastal AMCs without oil	(2) Coastal AMCs with offshore oil only
GDP per capita in 2002 (Brazilian R$2000)	3,934	8,058
Municipal revenues per capita in 2000 (Brazilian R$2000)	444	699
Population in 2000	161,784	93,372
Latitude	-13.3	-17.8
Longitude	42.0	42.1
Distance to the federal capital (kilometers)	1,401	1,180
State capital dummy	0.051	0.032
Distance to the state capital (kilometers)	106.1	99.2
Mean oil output per capita in 2000 (Brazilian R$2000)	0	3,894
90th percentile of oil output per capita in 2000 (Brazilian R$2000)	0	6,949
95th percentile of oil output per capita in 2000 (Brazilian R$2000)	0	21,319
Maximum oil output per capita in 2000 (Brazilian R$2000)	0	45,221
Observations (AMCs)	156	31

Notes: Each AMC includes one municipality or multiple municipalities. In all tables "Oil" denotes both oil and natural gas. All values reported are means, unless otherwise specified. Municipal revenues in 2000 are only available for 3,242 out of a total of 3,659 AMCs.

Table 2. Tests of Conditional Random Assignment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	GDP per capita	Average years of schooling among people aged 25 and over	Fraction literate among people aged 15 and over	Residential capital per capita	Percent of households with electric lighting	Percent of households with toilets linked to main network	Percent of households with water linked to main network	Total effect on family of outcomes
Oil output per capita in 2000	-0.031	-0.004	-0.033	-0.023	-0.116	0.016	0.093	-0.024
	(0.014)	(0.009)	(0.154)	(0.025)	(0.286)	(0.245)	(0.238)	(0.075)
Observations (AMCs)	187	187	187	187	187	187	187	187

Notes: Each cell reports the coefficient from a regression using a cross-section of AMCs (each AMC includes one municipality or more). The sample includes coastal AMCs without oil and coastal AMCs with offshore oil only. All values are in thousands of Brazilian R$2000. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table 3. The Effect of Oil Output Per Capita on GDP Per Capita, by Sector (2002)

	(1)	(2)	(3)
Dependent variable:	GDP Per Capita	GDP Per Capita in Industry	GDP Per Capita in Non-Industry
Oil output per capita	0.380	0.374	0.006
	(0.024)	(0.007)	(0.018)
Observations (AMCs)	187	187	187

Notes: Each cell reports the coefficient from a regression using a cross-section of AMCs (each AMC includes one municipality or multiple municipalities) in 2002. The sample includes coastal AMCs without oil and coastal AMCs with offshore oil only. Industry includes manufacturing, mineral extraction, civilian construction, and public utilities. The calculation of GDP in industry (and total GDP) from oil changed in 2002 - see paper for details. All values are in Brazilian R$2000. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table 4. Effect of Oil Output Per Capita on Municipality Revenues Per Capita

	(1)	(2)	(3)	(4)
	Total municipal revenues per capita in 2000	Total municipal revenues per capita in 2000 (see footnote)	Royalties from oil in 2000 (only AMCs in column 2)	Change in total municipal revenues per capita from 1991-2000 (see footnote)
Oil output per capita in 2000	0.0334	0.0334	0.0178	0.0311
	(0.0038)	(0.0038)	(0.0018)	(0.0031)
Observations (AMCs)	153	176	176	175

Notes: Each cell reports the coefficients on Oil Output per Capita in 2000 from a regression using a cross section of AMCs (each AMC includes one municipality or multiple municipalities). The sample includes coastal AMCs without oil and coastal AMCs with offshore oil only. All values are in Brazilian R$2000. Since we only have municipal revenues for about 91 percent of the AMCs in 2000, columns (2), (3), and (4) predict 2000 municipal revenues from 2001 municipal revenues using a linear regression to complete missing 2000 values. Similarly, in column (4) we use 1992 municipal revenues to predict missing 1991 values. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table 5. Effect of Municipal Revenues from Oil on Municipal Expenditures

	(1)	(2)	(3)	(4)	(5)	(6)
	Functional expenditures					Total
	Education and Culture	Health and Sanitation	Housing and urban development	Transportation	Social Transfers	
	Levels in 2000					
A: OLS	0.217	0.118	0.129	0.073	0.053	0.827
	(0.024)	(0.013)	(0.020)	(0.017)	(0.014)	(0.032)
B: IV	0.138	0.106	0.178	0.125	0.054	0.818
	(0.019)	(0.011)	(0.018)	(0.014)	(0.007)	(0.025)
Obs. (AMCs)	176	176	176	176	176	176
	Changes from 1991-2000					
C: OLS	0.207	0.098	0.116	0.077	0.052	0.782
	(0.025)	(0.020)	(0.028)	(0.018)	(0.016)	(0.039)
D: IV	0.147	0.105	0.173	0.117	0.052	0.823
	(0.019)	(0.011)	(0.021)	(0.014)	(0.007)	(0.033)
Obs. (AMCs)	174	174	174	174	174	174

Notes: Each cell reports the coefficient on municipal revenues per capita in 2000 from a regression using a cross-section of AMCs (each AMC includes one municipality or more). The dependent variables are measured in 2000 in Panels A and B and in changes from 1991-2000 in Panels C and D. Panels A and C report OLS coefficients, while Panels B and D report IV coefficients using oil output per capita in 2000 as an instrument. The sample includes all coastal AMCs without oil and all coastal AMCs with offshore oil only. All values are in Brazilian R$2000. Missing 2000 (1991) revenues were predicted using 2001 (1992) values and a linear regression. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table 6. Effect of Municipal Revenues from Oil on Housing and Infrastructure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Per capita residential capital	Rooms at home per 1000 people aged 16-64	Percent of population not living in favelas	Percent of population living in housing with electricity	Percent of population living in housing with garbage collection	Percent of population living in housing with piped water	Percent of households receiving water from the main network	Percent of households with toilets linked to the main network	Kilometers of paved roads under municipal jurisdiction per million people	Total effect on family of outcomes
	Levels in 2000 (except column 9, which is measured in 2005)									
A: OLS	-0.00003	0.096	-0.0031	0.0021	0.0077	-0.0019	-0.0075	0.0004	-0.004	-0.0013
	(0.00058)	(0.075)	(0.0030)	(0.0018)	(0.0028)	(0.0049)	(0.0088)	(0.0059)	(0.006)	(0.0017)
B: IV	-0.00141	0.086	-0.0141	0.0026	0.0120	0.0050	-0.0020	0.0030	-0.013	-0.0063
	(0.00102)	(0.122)	(0.0016)	(0.0025)	(0.0048)	(0.0032)	(0.0165)	(0.0117)	(0.007)	(0.0020)
Obs.	176	176	176	176	176	176	176	176	176	176
	Changes from 1991-2000									
C: OLS	-0.00044	-0.067	-0.0021	-0.0004	-0.0080	0.0030	-0.0022	-0.0077		-0.0026
	(0.00039)	(0.083)	(0.0014)	(0.0019)	(0.0042)	(0.0033)	(0.0071)	(0.0038)		(0.0015)
D: IV	-0.00061	-0.217	-0.0044	-0.0022	-0.0212	0.0012	-0.0065	-0.0122		-0.0061
	(0.00048)	(0.131)	(0.0016)	(0.0023)	(0.0098)	(0.0025)	(0.0074)	(0.0033)		(0.0008)
Obs.	175	175	175	175	175	175	175	175		175

Notes: Each cell reports the coefficient on municipal revenues per capita in 2000 from a regression using a cross-section of AMCs (each AMC includes one municipality or more). The dependent variables are measured in levels in Panels A and B and in changes in Panels C and D. Panels A and C report OLS coefficients, while Panels B and D report IV coefficients using oil output per capita in 2000 as an instrument. The sample includes all coastal AMCs without oil and all coastal AMCs with offshore oil only. All values are in Brazilian R$2000. Missing 2000 (1991) revenues were predicted using 2001 (1992) values and a linear regression. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table 7. Effect of Municipal Revenues from Oil on Education, Health & Transfers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Municipal teachers per million people	Municipal classrooms per million people	Municipal teachers per million people	Municipal classrooms per million people	Municipal hospitals per million people	Municipal clinics per million people	Social transfers per capita	Total effect on family of outcomes
	Levels in:							
	2000	2000	2005	2005	2002	2002	2000	
A: OLS	5.3	3.0	6.0	3.2	0.053	0.147	0.004	0.0067
	(1.5)	(0.8)	(1.7)	(0.8)	(0.042)	(0.059)	(0.004)	(0.0017)
B: IV	1.2	0.9	3.1	1.9	0.002	0.129	-0.002	0.0027
	(1.1)	(0.7)	(1.3)	(0.7)	(0.005)	(0.083)	(0.001)	(0.0013)
Obs. (AMCs)	176	176	176	176	176	176	176	176
	Changes from:							
	1996-2000	1996-2000	1996-2005	1996-2005	1992-2002	1992-2002		
C: OLS	1.9	1.1	3.1	1.6	0.042	0.145		0.0043
	(1.7)	(0.8)	(2.3)	(0.9)	(0.052)	(0.070)		(0.0022)
D: IV	-0.9	0.0	1.2	1.1	0.009	0.187		0.0014
	(1.1)	(0.6)	(1.5)	(0.8)	(0.008)	(0.073)		(0.0015)
Obs. (AMCs)	175	175	175	175	175	175		175

Notes: Each cell reports the coefficient on municipal revenues per capita in 2000 from a regression using a cross-section of AMCs (each AMC includes one municipality or more). The dependent variables are measured in levels in Panels A and B and in changes in Panels C and D. Panels A and C report OLS coefficients, while Panels B and D report IV coefficients using oil output per capita in 2000 as an instrument. The sample includes all coastal AMCs without oil and all coastal AMCs with offshore oil only. All values are in Brazilian R$2000. Missing 2000 (1991) revenues were predicted using 2001 (1992) values and a linear regression. For municipalities that did not report health establishments, we assumed that there were no health establishments. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table 8. Effect of Municipal Revenues from Oil on Household Income

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Per capita household income	Per capita household income: 1st (=bottom) quintile	Per capita household income: 2nd quintile	Per capita household income: 3rd quintile	Per capita household income: 4th quintile	Per capita household income: 5th quintile	Percent poor
	Levels in 2000						
A: OLS	0.727	0.088	0.147	0.288	0.639	2.677	-0.0028
	(0.317)	(0.036)	(0.074)	(0.132)	(0.289)	(1.122)	(0.0026)
B: IV	-0.038	0.086	0.037	-0.034	-0.173	-0.136	-0.0042
	(0.488)	(0.045)	(0.117)	(0.244)	(0.526)	(1.544)	(0.0036)
Obs. (AMCs)	176	176	176	176	176	176	176
	Changes from 1991-2000						
C: OLS	0.390	0.077	0.089	0.156	0.402	1.411	0.0000
	(0.191)	(0.035)	(0.055)	(0.085)	(0.167)	(0.714)	(0.0028)
D: IV	0.112	0.100	0.108	0.091	0.114	0.122	-0.0067
	(0.310)	(0.039)	(0.069)	(0.150)	(0.309)	(1.042)	(0.0027)
Obs. (AMCs)	171	171	171	171	171	171	171

Notes: Each cell reports the coefficient on municipal revenues per capita in 2000 from a regression using a cross-section of AMCs (each AMC includes one municipality or more). The dependent variables are measured in levels in Panels A and B and in changes in Panels C and D. Panels A and C report OLS coefficients, while Panels B and D report IV coefficients using oil output per capita in 2000 as an instrument. The sample includes all coastal AMCs without oil and all coastal AMCs with offshore oil only. All values are in Brazilian R$2000. Missing 2000 (1991) revenues were predicted using 2001 (1992) values and a linear regression. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table A1 (Part 1). Extended Summary Statistics

Variable	Mean	Std. deviation
GDP per capita in 2002	4,617.8	4,565.8
Total municipal revenues per capita in 2000	492.5	324.9
Population in 2000	150,443.3	484,869.6
Latitude	-14.0	9.9
Longitude	42.0	5.3
Distance to the federal capital (kilometers)	1,364.1	333.7
State capital dummy	0.0	0.2
Distance to the state capital (kilometers)	105.0	103.4
Oil output per capita in 2000	645.5	3,937.1
Average years of schooling among people aged 25 and over in 1970	1,665.7	1,563.1
Fraction literate among people aged 15 and over in 1970	1.6	1.0
Residential capital per capita in 1970	55.8	18.2
Percent of households with electric lighting in 1970	2.1	1.9
Percent of households with toilets linked to main network in 1970	28.1	25.2
Percent of households with water linked to main network in 1970	3.2	9.9
GDP per capita in 1970	16.6	22.0
GDP per capita in industry in 2002	1,214.2	2,624.5
GDP per capita in non-industry in 2002	3,403.6	2,860.2
Total municipal revenues per capita in 2000 (missing values predicted as in Table 4)	465.3	312.5
Royalties from oil in 2000	18.9	87.2
Municipal functional expenditures per capita on education and culture in 2000	129.1	75.1
Municipal functional expenditures per capita on health and sanitation in 2000	70.8	56.8
Municipal functional expenditures per capita on housing and urban development in 200(	53.7	64.8
Municipal functional expenditures per capita on transportation in 2000	23.5	40.5
Municipal functional expenditures per capita on social transfers in 2000	24.0	27.6
Total municipal functional expenditures per capita in 2000	426.3	284.0
Per capita residential capital in 2000	4.5	3.5
Rooms at home per 1000 people aged 16-64 in 2000	5,406.1	640.8
Percent of population not living in favelas in 2000	98.4	5.1
Percent of population living in housing with electricity in 2000	89.6	14.1
Percent of population living in housing with garbage collection in 2000	75.6	27.1
Percent of population living in housing with piped water in 2000	66.5	29.1
Percent of households receiving water from the main network in 2000	60.7	25.4
Percent of households with toilets linked to the main network in 2000	16.0	20.3
Kilometers of paved roads under municipal jurisdiction per million people in 2005	5.8	21.9
Municipal teachers per million people in 2000	7,678.8	3,599.3
Municipal classrooms per million people in 2000	4,168.6	2,236.3
Municipal teachers per million people in 2005	8,999.7	4,575.5
Municipal classrooms per million people in 2005	4,506.2	2,445.2
Municipal hospitals per million people in 2002	15.0	42.4
Municipal clinics per million people in 2002	308.4	221.8
Social transfers per capita in 2000	8.8	7.5

Notes: This is part 1 of a Table that reports means and standard deviations of the variables for the sample, which includes coastal AMCs without oil and coastal AMCs with offshore oil only (187 AMCs in total).

Table A1 (Part 2). Extended Summary Statistics

Variable	Mean	Std. deviation
Per capita household income in 2000	2,331.3	1,684.4
Per capita household income: 1st (=bottom) quintile in 2000	288.1	238.1
Per capita household income: 2nd quintile in 2000	763.0	524.9
Per capita household income: 3rd quintile in 2000	1,265.0	875.5
Per capita household income: 4th quintile in 2000	2,138.6	1,585.9
Per capita household income: 5th quintile in 2000	7,185.6	5,386.2
Percent poor in 2000	47.5	24.2
Log population in 1970	10.0	1.3
Log population in 1980	10.2	1.3
Log population in 1991	10.5	1.3
Log population in 1996	10.6	1.4
Log population in 2000	10.8	1.4
Log population in 2005	10.9	1.4
Population in 1970	76,789.0	331,061.0
Population in 1980	101,062.3	402,278.1
Population in 1991	126,724.8	444,744.6
Population in 1996	136,837.5	456,864.0
Population in 2005	171,930.3	529,130.9
Fed. and State teachers per million people in 2000	4,300.9	2,412.6
Fed. and State classrooms per million people in 2000	1,781.3	1,092.4
Fed. and State teachers per million people in 2005	3,852.8	2,197.9
Fed. and State classrooms per million people in 2005	1,578.5	1,000.5
Fed. and State hospitals per million people in 2002	2.6	7.5
Fed. and State clinics per million people in 2002	5.3	23.8
Km. of paved roads under non-municipal jurisdiction per million people in 2005	1.87E+09	2.47E+09
Value of Fed. contracts per capita in 2000	28.3	70.7

Notes: This is part 2 of a Table that reports means and standard deviations of the variables for the sample, which includes coastal AMCs without oil and coastal AMCs with offshore oil only (187 AMCs in total).

Table A2. No Significant Effect of Oil on Population

	(1)	(2)	(3)	(4)	(5)	(6)
	1970	1980	1991	1996	2000	2005
A: Dependent variable: ln(population)						
Oil output per capita in 2000	-0.0000262	-0.0000267	-0.0000221	-0.0000179	-0.0000183	-0.0000184
	(0.0000143)	(0.0000138)	(0.0000136)	(0.0000128)	(0.0000121)	(0.0000114)
B: Dependent variable: population						
Oil output per capita in 2000	-8.5	-10.7	-11.5	-11.5	-12.1	-13.1
	(6.3)	(7.5)	(7.9)	(7.9)	(8.2)	(8.9)
Observations (AMCs)	187	187	187	187	187	187

Notes: Each cell reports the coefficient on oil output per capita in 2000 from an OLS regression using a cross section of AMCs (each AMC includes one municipality or more). Panel A uses log population as outcomes, while Panel B uses population in levels as outcomes. The sample includes all coastal AMCs without oil and all coastal AMCs with offshore oil only. All values are in Brazilian R$2000. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses.

Table A3. Test for Crowding Out of State and Federal Investments

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Fed. and State teachers per million people	Fed. and State classrooms per million people	Fed. and State teachers per million people	Fed. and State classrooms per million people	Fed. and State hospitals per million people	Fed. and State clinics per million people	Km. of paved roads under non-municipal jurisdiction per million people	Value of Fed. contracts per capita	Total effect on family of outcomes
	Levels in:								
	2000	2000	2005	2005	2002	2002	2005	2000	
A: OLS	-1.2	-0.5	-1.2	-0.4	0.000	-0.004	2.5	0.0105	-0.0010
	(0.6)	(0.2)	(0.5)	(0.2)	(0.002)	(0.004)	(1.7)	(0.0145)	(0.0006)
B: IV	1.2	-0.1	0.8	0.0	0.005	-0.014	0.8	-0.0225	0.0001
	(0.9)	(0.3)	(0.8)	(0.3)	(0.004)	(0.010)	(0.7)	(0.0171)	(0.0011)
Obs. (AMCs)	176	176	176	176	176	176	176	176	176
	Changes from:								
	1996-2000	1996-2000	1996-2005	1996-2005	1992-2002	1992-2002			
C: OLS	-1.1	-0.4	-1.0	-0.2	-0.005	-0.251			-0.0029
	(0.5)	(0.2)	(0.5)	(0.3)	(0.008)	(0.137)			(0.0011)
D: IV	-0.5	-0.5	-0.9	-0.4	-0.003	-0.096			-0.0019
	(0.6)	(0.5)	(0.7)	(0.5)	(0.005)	(0.034)			(0.0014)
Obs. (AMCs)	175	175	175	175	175	175			175

Notes: Each cell reports the coefficient on municipal revenues per capita in 2000 from a regression using a cross-section of AMCs (each AMC includes one municipality or more). The dependent variables are measured in levels in Panels A and B and in changes in Panels C and D. Panels A and C report OLS coefficients, while Panels B and D report IV coefficients using oil output per capita in 2000 as an instrument. The sample includes all coastal AMCs without oil and all coastal AMCs with offshore oil only. All values are in Brazilian R$2000. Missing 2000 (1991) revenues were predicted using 2001 (1992) values and a linear regression. For municipalities that did not report health establishments, we assumed that there were no health establishments. All regressions control for latitude, longitude, coast dummy, state capital dummy, distance to the state capital, distance to the federal capital, and state dummies. Robust standard errors are in parentheses. We have no data on roads or federal contracts for 1991. Robust standard errors are in parentheses.

Table A4. News About Allegations of Corruption and Fraud in Oil-Rich Municipalities

Rank (Oil Output in 2000)	Rank (Per Capita Oil Output in 2000)	Municipality	Event	Authority involved	Amount involved	Source
1	4	Campos dos Goytacazes	Mayor removed from office and several associates arrested in a case involving fraud in bidding and illegal hiring in the city council.	Federal Police Operation "Telhado de Vidro"	Up to R$240 million	O Globo, O Dia Online
3	12	Macaé	State prosecution took legal action against the mayor between 1988-2004, who is accused of misusing public funds and participating in a scheme directing biddings for contracts of municipal works.	Prosecution of the State of Rio de Janerio	Not specified	Gazetta Mercantil
"	"	"	Re-elected mayor and ex-mayor accused of dishonest administration and cheating in bidding of school lunches.	Federal Public Prosecution	Cumulative R$ 1.5 million	Agencia Brasil
5	20	Cabo Frio	Former mayor and current senior municipal employee exchange allegations regarding an investigation by the federal police that targeted the municipality (among other municipalities).	Federal Police Operation "Joao de Barra"	Estimated R$700 million (over many municipalities)	Agencia Brasil, O Globo, Jornal do Brasil
6	10	Coari	Mayor and associates arrested in a federal police operation under allegations of corruption and criminal organization. This criminal organization was accused of directing bids, overbilling, and faking work to appropriate resources allocated by the federal government and Petrobras for the exploration of oil and gas. 24 hours later, the headquarters of the daily newspaper, Diario do Amazonas, which reportedly covered the case, was attacked by gunshots.	Federal Police Operation "Vorax"	Allegedly at least R$50 million	Agencia Brasil, Ultimo Sequndo, and a blog
"	"	"	Mayor accused by a federal prosecutor of fraudulently obtaining social security funds.	Federal Public Prosecution	Allegedly at least R$1.5 million	Agencia Brasil
8	5	Armação de Búzios	Mayor ordered to appear before the state court to explain irregularities in accounts.	Court of the State of Rio de Janerio	Not specified	Amarribo (an NGO)
9	3	Carapebus	Two former mayors accused of corruption and fraud in bidding and were investigated as part of a federal police operation	Federal Police Operation "Pasárgada"	Not specified	O Globo

Notes: This table lists journalistic accounts of events involving alleged fraud, corruption, and other illegal activities associated with mayors in municipalities that ranked in the top 10 in Brazil in total oil output in 2000.