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The Effect of Oil Windfalls on Political Corruption: Evidence from Brazil

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The dissertation of Kathryn Baragwanath Vogel is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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DEDICATION

To my family, the one I was born into and the one I chose.

EPIGRAPH

All models are wrong,

but some are useful.

—George E.P. Box

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ABSTRACT OF THE DISSERTATION

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by

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Oil royalties provide a substantial and volatile inflow of non tax-payer money to municipal coffers, creating dynamic incentives for politicians in office. Resource windfalls change politicians' budget constraints, generate difficulties for voters to distinguish politicians' integrity, and create incentives for corruptible candidates to enter politics, changing the pool of candidates. Using a formal model with moral hazard and adverse selection, I show how resource windfalls generate the endogenous entry of worst candidates into politics, which generates cycles in corruption and reelection patterns. In Brazil, where offshore royalties are determined and allocated exogenously, oil inflows create strong opportunities for corruption. I find strong effects of oil windfalls on corruption. On average, a one standard deviation increase in oil royalties produces a 29% increase in corruption. The effects of windfalls on corruption are larger after elections during booms and lower during busts.

Furthermore, oil royalties lead to a reelection cycle: when the price of oil is expected to be higher, incumbents are reelected more often than when the price of oil is expected to fall, independent of economic and individual level variables. I show that endogenous entry of worse candidates during booms is likely the cause of these corruption and reelection cycles, as predicted by the theory. Taken together, these results point to a strong effect of oil royalties on local level political equilibria.

1 Introduction

"I have always said, since the Petrobras discoveries, that it has been proven that God is Brazilian", Brazil's President Lula da Silva said in a press conference in November of 2007.[1] Earlier that year, he had announced that the oil discoveries off the shores of the Brazilian coast were a "gift from God"[2] and Dilma Rouseff, who would become Lula's successor, announced that the income from royalties would mean "more houses, more food and more health"[3] for Brazilians. It seemed, in fact, that the universe was conspiring in Brazil's favor. Since the early 2000s, offshore oil production had began steadily increasing. The price of oil was experiencing an unprecedented boom and in the middle of this bonanza, Brazil had just discovered enormous new offshore oil deposits. God might as well have been Brazilian.

But would these newfound resources be a blessing or a curse? Across the globe, examples of the well known "Resource Curse" abound. Political scientists have established a large and growing literature on the harmful effects of oil on politics. Most of this literature has focused on the harmful effects oil can have on Democracy, as exemplified in Friedman's famous "First Law of Petropolitics", where he states that "The price of oil and the pace of freedom always move in opposite directions in oil-rich petrolist states" (Friedman 2006). The main argument of this strand of the literature is that oil rents help entrench autocrats by providing a substantial source of non-tax income which is difficult to observe by voters and which can be used to further entrench the autocrat's hold on power. However, the detrimental effects of oil on politics might be less evident and more subtle, especially

[1] https://www.jb.com.br/pais/noticias/2007/11/20/lula-esta-provado-que-deus-e-brasileiro.html

[2] "dádiva de Deus" in Portuguese, https://www1.folha.uol.com.br/fsp/brasil/fc1111200721.htm

[3] "mais casas, mais comida, mais saúde", in Portuguese https://www1.folha.uol.com.br/fsp/dinheiro/fi0109200902.htm

in developing democracies. An emerging literature focuses on the harmful effects that mineral resources can have on more nuanced outcomes within democracy, without necessarily leading to democratic breakdown.

In Brazil, the offshore oil discoveries promised development and prosperity. However, as income from oil exploration flooded the government's coffers, sometimes doubling or tripling the government budgets, citizens in the places most affected by the windfalls from oil royalties saw little to no improvement in their welfare. Fueled by the windfalls, corruption scandals involving the affected local governments plagued their political landscape, as government funds went missing or were spent in suspect ways, enriching private actors at the cost of the citizens of Brazil.

Presidente Kennedy, a small coastal municipality in the state of Espírito Santo, is a case in point. Between 2005 and 2018, this small municipality was the highest royalty receiver in the state of Espírito Santo, pushing it to first place in the ranking of municipalities in terms of revenue per capita in the entire country. However, only 38% of Presidente Kennedy's residents had access to clean water and sewage systems and only 10% of its roads were paved. Additionally, about half of the municipality's population is dependent on some type of federal aid program like Bolsa Família, and the municipality ranks in the lower half of the distribution in terms of child mortality and educational attainment. How is it that the richest municipality in revenue per capita terms has such negative socio-economic indicators? One possible answer to this question is corruption. Since 2004, all of its elected mayors have been investigated and linked to corruption scandals. This case motivates the puzzle: Does increased access to oil revenues generally lead to an increase in corruption? And if it does, what explains this relationship?

This dissertation explores the effects of natural resource windfalls on political accountability and corruption. Resource windfalls hamper accountability between voters and their representatives, and also have important effects on the quality of the political class, leading to more corruption. I argue that resource windfalls: (1) change politicians' budget constraints, (2) generate difficulties for voters to distinguish politicians' integrity, and (3) create incentives for corruptible candidates to enter politics, changing the pool of candidates that voters can use to replace incumbents. Resource

windfalls thus produce corruption and electoral cycles, as they change the quality of the pool of candidates running for office.

I develop a general theoretical framework to understand the relationship between resource windfalls and political corruption. The dissertation provides micro-foundations and a careful empirical test of the mechanisms using Brazil as a case. I argue that selection into politics is driven by embezzlement opportunities, which natural resource windfalls alter by changing incumbents budget constraints and obscuring voters evaluation of their performance. As such, these resources create incentives for dishonest candidates to enter politics, which in turn generates reelection and corruption cycles which follow the international price cycles. A key implication of my theory is not only that more money is associated with more corruption; but, more importantly, that fluctuations of the revenue flows play a central role in shaping the integrity of the political class.

Using a natural experiment in Brazil, I empirically evaluate these claims. I find strong empirical support for this argument. I find significant effects of oil royalties on corruption outcomes, in line with the predictions of my theoretical model. Municipalities that receive oil royalties have systematically higher levels of corruption than those that do not receive royalties. In fact, I find that a one standard deviation increase in income from royalties leads to a 29% increase in the fraction of funds used in a corrupt manner. Furthermore, corruption in royalty receiving municipalities is higher when the incumbent was elected during a boom and lower when he was elected during a bust, as predicted by the theory.

Additionally, oil royalties lead to a reelection cycle: when the price of oil is expected to be higher, incumbents are reelected more often than when the price of oil is expected to fall, independent of economic and individual level variables. These findings suggest that the corruption cycles identified are caused by the electoral dynamics generated by the windfalls which hamper the selection of good politicians and lead to entry of more venal types into politics. Further, findings on the types of expenditure undertaken by windfall affected municipalities support the theory by showing that there is a diversion of funds towards activities which are more prone to corruption, and away from activities which are more closely audited by federal entities, in royalty receiving

municipalities.

Finally, I present results that suggest that the endogenous entry of more dishonest candidates during booms is likely the cause of these corruption and reelection cycles, as predicted by the theory. I then proceed to recover the unobserved parameters of the model by calibrating the model and obtaining the average dishonesty of the pool of candidates and the rates at which incumbents pool. Since both of these parameters and the politician type are unobserved variables, reduced form estimates may confound the effects of these parameters with other, observed, variables. This exercise allows me to recover these important parameters, conduct comparative statics and analyze the channels through which oil windfalls cause the corruption and reelection cycles I identify.

In the rest of this introductory chapter, I provide some context of the oil boom of the 2000s, the backdrop against which the case of Brazil is studied. I then briefly present the Brazilian case, and provide arguments as to why it is an exemplary case through which to study the effects of oil windfalls on corruption. I proceed to define some key concepts which will be analyzed throughout the dissertation, such as windfalls and corruption. Finally, I close the chapter with an outline of the dissertation.

1.1 The Oil Boom of the 2000s

The decade of the 2000s saw an unprecedented era of commodity price booms, and oil was at the center of this historical process. The price of oil rose from around $30 in 2003 to $60 in 2005, and peaked at $147.3 in 2008. The expected growth of BRIC economies like China, India and other emerging economies led to an increase in the price of commodities that had not been seen to date. This, together with reports from the US Department of Energy and the US Government Accountability Office (GAO)[4] showing declining oil reserves, political tension in the Middle East and an unpredictable oil supply from important oil producing states like Iran, Nigeria and Libya generated a sustained increase in the international price of oil (Gillies 2020). Between 2001 and

[4]https://www.gao.gov/products/gao-07-283

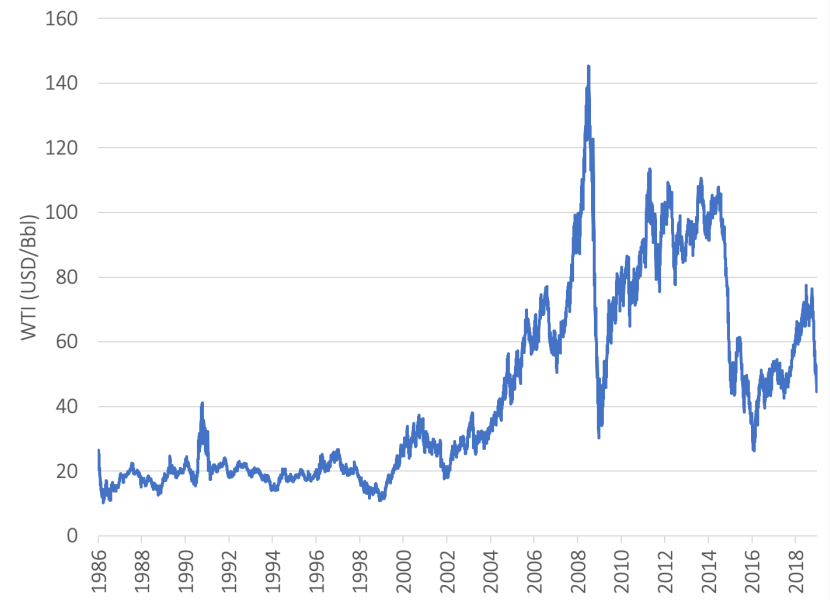


Figure 1.1: Historical Price of Oil (WTI - USD/Bbl)

2018, the price of a barrel of oil fluctuated between around $18 to over $140. However, although the period as a whole is categorized as a boom there is important variation within the period, and unpredictable fluctuations in the price of oil remain the norm. The important drop in 2008 and 2009 following the financial crisis is a case in point. This fall then led to a recovery and a rebound of the price in 2011, back to about $120. The period I study in this dissertation comprises this important boom and bust period observed between 2000 and 2016.

Throughout this period, oil rich nations saw their government budgets bloat. In Latin America, countries like Bolivia, Ecuador, Mexico, Venezuela and Brazil experienced important inflows of government revenues from the extraction of oil and natural gas. However, today these countries find themselves in turbulent political waters, with weakened economies and a society which severely distrusts its political class. In general, resource rich and especially oil rich countries in Latin America remain "democratic" on paper[5], however, the quality of their democracies has suffered seriously. Beginning in the late 1990s and into the early 2000s, Venezuela, Bolivia and Ecuador (the three main oil exporters in the region) began a process of dismantling checks and balances, passing constitutions that seriously concentrated power on the executive (Acemoglu et al.

[5]With the exception of Venezuela which is now classified as a closed anocracy by Polity IV.

2013). Additionally, Venezuela, Ecuador, Brazil, Argentina and even Chile have seen scandalous episodes of corruption following a period of high oil, gas and mineral prices. But how can we establish that the precarious political scenarios in these places were *caused* by oil? How can we know if the main channel through which oil affected politics in these places was through its effects on corruption? Going micro and looking at the Brazilian case may provide some answers to these questions.

1.2 The Case of Brazil

Fueled by the oil boom and the discovery of new oil reserves, the Brazilian oil sector grew in line with the rise in the price of oil. Offshore oil production began ramping up in the early 2000s. By 2007, with the discovery of large oil deposits in the pre-salt, a layer located in ultra deep waters in the Southeast offshore region of the country, Brazil consolidated itself as an important oil producer in the world stage. Total oil production went from 1.2 million barrels per day in 2000 to 2,7 million barrels per day in 2016[6]. The total government revenue from royalties and other government payments from oil extraction grew from BR$ 81 million in 1997, to BR$6.4 billion in 2000 to BR$24 billion in 2008 (with a fall to BR $16 billion in 2009) and reaching almost BR $39 billion in 2018[7].

Brazil provides an interesting case to study the effects of windfalls on local politics because of the decentralized way in which royalties from oil exploration are distributed to local governments. In Brazil, oil royalties are distributed on a monthly basis to States and Municipalities as a way of compensating for the exploitation and production of petroleum and natural gas. These royalties began to be distributed when the state-owned oil company, Petroleo Brasileiro SA (Petrobras) was created in 1953. The rule for the distribution of offshore royalties (which only began to be explored later in time) was based on a law passed in 1985. At this point, Brazil was not a large producer of oil, and most of its reserves were onshore. The expectation was that any future discoveries would

[6]Source: ANP http://www.anp.gov.br/

[7]BR $ 24 bilion in royalties and BR $15 billion in other government payments like special participations (ANP)

likely be found in the North East of Brazil (Brambor 2016).

Under this law, a municipality is considered a producing municipality, and thus receives royalties, if it faces an oil well, according to the parallel and orthogonal lines which stem from the municipalities borders when they reach the ocean. These lines were not defined by political negotiations and were not subject to municipal interests since they were defined by the IBGE (Instituto Brasileiro de Geografia e Estatistica - Brazilian Institute of Geography and Statistics) based on geodesic lines. Offshore royalties are thus exogenously determined, as municipalities have little capacity to determine where oil fields will be located, and once these rules were set in 1985, they could not modify their geographic characteristics. Additionally, offshore production represents 90% of total oil production in Brazil, and the infrastructure dedicated to provide support and services to this offshore production is concentrated in one city in Rio de Janeiro, Macaé (Ferraz and Monteiro 2014). This institutional setup provides a natural experiment in which to explore the effects of oil on political outcomes[8].

Brazil also has some of the best micro-level data on actual corruption levels, as opposed to perceived corruption. In 2003 the federal auditing agency began a lottery system where it randomly selected municipalities to be audited, creating in depth audit reports which serve as our corruption measure. The audits flag instances of malfeasance such as fraudulent procurement processes, over-invoicing, missing funds, contracts with ghost firms and other common forms of corruption in the Brazilian context[9]. The Brazilian case is thus exemplary for testing the micro-level effects of oil windfalls on corruption at the municipal level, enabling us to establish causal effects of windfalls on corruption.

[8]For more information on the oil sector in Brazil and the distributional rule, please see Chapter 4, sections 4.12 and 4.13

[9]For more information on the audits and the corruption measure used in this dissertation please see Chapter 4, section 4.3.

1.3 Defining Windfalls and Corruption

This dissertation explores the effects of oil windfalls on corruption. As such, it is important to define what I mean by oil windfalls and corruption in order to establish a clear framework for the rest of the study. The Merriam Webster dictionary definition of windfall is "an unexpected, unearned, or sudden gain or advantage"[10]. The key concepts for this dissertation have to do with the unearned characteristics of oil windfalls. In the context of this study, oil windfalls are distributed to municipalities without them having to engage in any type of economic or political activity in order to access gain these funds. As such, we consider these resource or oil windfalls as sources of government funding which are in large part independent of the government's actions. Additionally, windfalls are "unexpected" and or "sudden" gains. Here, the key concept has to do with the volatility of the resources which is another important component of the theory, especially when thinking about the cyclical nature of the windfalls. Expectations over future windfalls play a key role in the theory, and as such the volatile price cycle generates much of the perverse effects that windfalls have on political outcomes. Thus, for the purposes of this dissertation, when I talk about oil windfalls, I am referring to the "unearned gain" that materializes as oil royalties, which directly result from the exploration of oil located in offshore oil fields and is independent of the municipal government's competence and actions.

What do I mean by corruption? In order to study the effects of windfalls on corruption, I first must define the concept of corruption. A large and important literature in both political science and economics has studied corruption and attempted to define and measure it (Svensson 2005; Treisman 2007; Golden and Fisman 2017). Additionally, measures of corruption created by NGOs like Transparency International have become important in order to understand patterns and causes of corruption throughout the world. However, a simple definition of corruption is not always straightforward, and in many instances researchers and policy makers refer to different things when they speak of corruption.

[10]Merriam Webster https://www.merriam-webster.com/dictionary/windfall

Throughout this dissertation, when I speak of corruption, I am referring to the definition from Fisman and Golden (2017): corruption is the exploitation of public office for private gain. In other words, corruption always involves a public or government official using his or her office in order to achieve some personal enrichment. This personal enrichment could be monetary, i.e. stealing money directly from the public coffers, or it could be non monetary, i.e. gaining access to a new job, vacations, wining and dining or some sort of special treatment. It can also be a direct enrichment or benefit, i.e. the politician is personally benefiting directly, or it could be indirect, i.e. a family member or friend is gaining access to the benefit, but this in turn benefits the public official indirectly.

As mentioned above, Brazil has some of the best micro-level data on actual corruption levels, as opposed to perceived corruption. In 2003 the auditing agency, CGU (Controladoria-Geral da União) began randomly selecting 50 municipalities that fit the population threshold to be audited[11]. The number then rose to 70 randomly selected municipalities. Due to the population cut-off, this process excludes approximately 8 percent of Brazil's 5,500 municipalities, comprising mostly the state capitals and some coastal cities which are more heavily populated.

Using this information, I create a corruption variable which identifies the fraction of a municipality's budget that was subjected to corrupt actions. This data set is the best available for the study of local level corruption in Brazil, since the randomization of the audits eliminates any bias in the measure of corruption which could result from selection of municipalities into being audited. Common concerns with measures of corruption through audits that are not randomly assigned include issues like: (i) municipalities that are more corrupt are more likely to be audited, which leads to overestimation of corruption; (ii) politically connected municipalities are less likely to be audited, and if these are also more corrupt, then corruption would be underestimated. Given the random assignment to audits, the data used for this project is free of these issues. The types of corrupt acts covered by the dataset include fraud in procurement activities, missing funds or diversion of funds, over-invoicing and other inconsistencies in the municipalities' finances such as

[11]The official threshold has varied through time, but has eventually stabilized at municipalities with less than 500,000 inhabitants

face receipts or invoicing fake firms. More information on the definition, measurement and creation of this variable can be found in Section 4.3 of Chapter 4.

Although I focus on this narrow definition of corruption, some broader definitions of corruption are useful in different settings. For example Transparency International defines corruption as the "abuse of entrusted power for private gain" (Fisman and Golden 2017), which allows us to interpret self serving acts by corporate executives that are not in the best interest of shareholders as corruption. Thus, under this broader definition of corruption, there is no need for a public official to be involved: for example, corruption may take place between two private entities. This is also the approach taken by Alexandra Gillies in her important new book "Crude Intentions: How Oil Corruption Contaminates the World", where she exposes how oil corruption is pervasive around the world. Gillies places an important focus on private entities like construction companies, banks and other financial service companies in her study of oil fueled corruption. For her, corruption is not restricted to government officials, but rather can take place between private actors as well. For the purposes of this dissertation, and in order to keep the definition simple and clear, I will use the more restrictive definition exposed above: corruption here is defined as the abuse of entrusted power in public office for private gain, and is measured using the random audits at the municipal level.

1.4 Core Contributions

While most of the literature on the resource curse discusses whether natural resources enhance the stability of autocratic regimes, we know much less about how natural resources affect the quality and functioning of democracy. A few recent studies examine the impact of resources on corruption, but most of them ignore the cyclical nature of the resource windfalls, do not consider equilibrium effects including incentives for entry into politics or suffer from identification concerns. To this emerging literature on the impact of oil resources on political outcomes in democracies, I make one theoretical and two empirical contributions.

First, the theory provides micro-foundations linking resource windfalls to corruption. By

focusing on politicians' incentives, I can account not only for the relationship between windfalls and corruption levels, but also for the dynamic effects produced by price cycles. The theory is based on a formal model with moral hazard and adverse selection, where the politician can either be honest or dishonest, and voters do not directly observe his type. The politician competes with a pool of challengers, all of which can either be honest or dishonest. The politician can decide how much to embezzle, but voters can infer from their welfare whether the politician has stolen or not, and thus update their beliefs on politician type. Resource shocks create more uncertainty in voters' updating process, making it more difficult to identify honest types in the presence of these shocks. Given this, the politician may, under some circumstances, have incentives to act as if he were honest in order to ensure reelection, and thus steal in the next period.

Positive shocks, such as large exogenous windfalls created by oil shocks, generate interesting dynamic incentives for politicians and candidates. Larger flows of cash into government's coffers generate more opportunities to embezzle funds. Additionally, the shock generated by these windfalls creates a noisy signal to voters, making it more difficult to differentiate good types from bad types. Finally, the expectation of future inflows generates dynamic incentives for both incumbents and possible candidates. During booms, the incentive for dishonest politicians to pool with honest ones, and behave as if they were honest, is large given the expectation of more embezzlement opportunities in the future, leading to the reelection of more bad types. Furthermore, periods of booms attract more dishonest citizens into political careers, generating an additional effect on the reelection of dishonest types in office. This theory not only helps explain the observed reelection cycles in commodity dependent countries, where incumbents get reelected during booms and are voted out during busts, but also helps explain differences in the pool of candidates between royalty receiving and non-royalty receiving places, as well as during booms and busts.

My second contribution is empirical. Almost all research on the relationship between natural resource rents and political corruption is based on observational evidence and thus beset with identification problems. Oil production is potentially endogenous to the honesty of elected officials. In addition, oil windfalls determine embezzlement opportunities, affecting both the choice

of citizens to run for office and the performance of those who are elected.

To overcome these difficulties, I focus on the Brazilian case. Since 1997, Brazil has distributed oil royalties to its municipalities based on an exogenous geographic rule and the international price of oil. This means that the amount of royalties a municipality receives in each period cannot be affected by the actions of the mayor in office, making Brazil an exemplary case study. Additionally, starting in 2003, the Controladoria-Geral da União (CGU - Federal Auditing Agency) began a random audit program where it randomly selected municipalities to be audited in depth. This data provides a representative sample of corruption outcomes in Brazilian municipalities, allowing for the identification of honest vs. dishonest politicians based on actual observed behavior.

The use of municipal level data resolves many of the issues that arise with cross-country data. In fact, recent work has moved towards identifying micro-level effects, exploiting within country differences of resource wealth, corruption and other relevant outcomes such as economic growth, living standards, civil conflict and public goods provision (Dube and Vargas 2013; Carreri and Dube 2017; Caselli and Michaels 2013; Maldonado 2014; Martinez 2016; Ferraz and Monteiro 2014; Postali 2009; Vicente 2010). This approach is not only useful because it isolates the unobservable differences among countries, keeping general characteristics constant across observations, but it is also useful given the unreliable cross country data on corruption. In the case of Brazil the micro-level data helps us overcome these difficulties because, first, mayors have little say over extraction rates of oil in Brazil, especially in municipalities with offshore production. Oil production is highly centralized in Petrobras, the Brazilian National Oil Company, and decisions are made at higher administrative levels than municipalities. Second, Brazilian municipalities vary greatly in their reliance on oil royalties, which provides an excellent empirical test for both the effects of oil rents on corruption at the extensive margin (whether or not municipalities receive oil rents), and the intensive margin (how much oil rents they receive, which varies with production and price of oil). Third, offshore royalties are determined by an exogenous rule based on geographical location and the international price of oil (Caselli and Michaels 2013; Bhavnani and Lupu 2016), and offshore oil drilling does not significantly affect local economic outcomes (Caselli and Michaels 2013;

Cavalcanti et al. 2019).

The third contribution is also empirical. I rely on a calibration exercise to identify the effects of windfalls on decisions made by incumbents, voters and potential challengers. The incorporation of these three interrelated decision-making processes creates better estimates of the true impact of oil on corruption, and allow me to establish a causal identification of the mechanisms involved. By using the model's structure, I can disentangle the sanctioning effect from the selection effect from the entry effect. Using this method, I can quantify the effects of pooling and entry into politics.

These findings provide important insights into the micro-foundations of the oil curse and its dynamic effects. The results are generalizable to any place that is exposed to the fluctuations of the international commodity price cycle, especially those where a large part of the government budget is dependent on such price. Insulating local governments from such fluctuations could be a simple yet effective way of addressing many of the issues created by natural resource shocks.

1.5 Outline of the Dissertation

In the remainder of this dissertation, I develop a theory of oil windfalls and corruption in which actors' incentives are shaped by the expectations of future rents which vary with the international price cycle. I then test that theory from several angles using a natural experiment in Brazil, and I develop a calibration exercise based on the theoretical model in order to recover unobserved parameters which help identify the mechanisms through which oil windfalls affect accountability and corruption.

In Chapter Two, I outline the ways through which natural resource windfalls might affect actors' incentives and thus lead to corruption and reelection cycles. First, I discuss the role that natural resource windfalls and price cycles, specifically booms and busts, have on incumbent politicians decisions about how much corruption to engage in while they are in office. Here, politicians are thought to be undertaking a calculus which compares the benefits of extracting as much as possible in the current period in the form of corruption versus extracting less in the effort

to win reelection and thus hold office for a second period, where there will be new opportunities for rent extraction. This calculus will, consequently, be importantly affected by the price of oil which will determine the amount of royalties expected to flow into the municipal coffers in the following period in ways I will explore below.

Second, I examine how these price cycles affect the decisions of citizens to enter into politics, thus changing the quality of the politician pool in places affected by windfalls. This second mechanism considers all citizens as potential politicians, where the decision whether to actually become a politician or not will depend on the expected rent extraction possibilities that holding office would provide, as well as the expected wage outside of politics. Driven by the possibility of higher rent extraction, oil windfalls lead to more dishonest citizens entering into politics during booms, which compounds the effects of oil windfalls on corruption. Together, these two mechanisms lead to electoral and corruption cycles generated by oil windfalls and changes in the quality of the pool of candidates. A key implication of the theory is not only that more money is associated with more corruption; but, more importantly, that fluctuations of the revenue flows play a central role in shaping the integrity of the political class and the corruption and reelection outcomes.

In Chapter Three, I present a formal exposition of the theoretical model using a simple mathematical model. The main goal of this model is to shed light on the mechanisms through which natural resource windfalls can change the local political dynamics. The framework is based on a simple model of political agency where incumbents must decide how much of the budget to steal and how much to spend on public goods provision, and citizen-candidates must decide: (i) whether to reelect an incumbent or not and (ii) whether they want to enter into politics and challenge the incumbent as a candidate. The model shows how oil shocks affect corruption and reelection levels through three distinct channels: (i) ex ante selection: oil shocks affect the type of politician who decides to run for office; (ii) moral hazard: oil shocks affect the incentives politicians have while in office; and (iii) ex post selection: oil shocks can affect the capacity of voters to evaluate politician type and select good politicians.

The model generates a set of predictions which can then be tested on the data. First, the

model predicts that corruption will be higher in windfall affected municipalities. Furthermore, the model predicts that corruption will be higher in windfall affected municipalities following an election during a boom period, and lower following an election held during a bust period, creating a cycle of corruption which follows the international price of oil. Second, the model predicts that windfall affected municipalities will have higher reelection rates for elections held during boom periods, reelecting more dishonest politicians, and lower reelection rates for elections held during bust periods, voting out dishonest politicians. These results are in part driven by the entry of more dishonest candidates into politics, so the effects of windfalls on the integrity of the political class is, again, a crucial aspect of the model.

In Chapter Four, I dive deeper into the context and measurement. In section 4.1, I describe the Brazilian context, where I focus on the institutional context and the role that municipalities play in the Brazilian political structure, as well as an in depth description of the Brazilian oil industry and the laws regulating it. Brazil is a federal presidential constitutional republic composed of 26 states and 1 federal district. Within these states, there are a total of 5,570 municipalities which vary greatly in size, population and socio-economic characteristics. Brazil is considered one of the most decentralized federal systems in the world, with local governments carrying a large responsibility in government service provision. Municipalities are the main entities responsible for providing education, primary health care and other public services such as local infrastructure, transportation and in some cases a local police force. Each municipality is governed by a mayor ("prefeito" in Portuguese) which is elected every four years and can serve two consecutive terms in office. Mayors have great discretion as to how they spend their budgets and are important political figures in the local context. While as a federation Brazil is highly decentralized, the oil sector is highly centralized. The Brazilian Union owns the oil under Brazilian land and the federal government has the responsibility of extraction, production, transportation and commercialization of the resource through Petrobras, the national oil company. The Brazilian government charges a royalty for the extraction of oil, which is distributed on a monthly basis to States and Municipalities as a way of compensating for the exploitation and production of petroleum and natural gas. This section

provides an in depth description of the laws and bodies governing the Brazilian oil sector, and how the current royalty rule came about.

In section 4.2, I explain the measurement of the main independent variable: oil windfalls. I exploit a natural experiment whereby royalties are allocated to municipalities based on an exogenous geographic rule and the international price of oil. For offshore production, a municipality is considered a producing municipality, and thus receives royalties, if it faces an oil well, according to the parallel and orthogonal lines defined in a 1985 law. These lines were not defined by political negotiations and were not subject to manipulation according to municipal interests since they were defined by the IBGE based on geodesic lines, and are thus exogenous to local political characteristics. I use offshore royalties determined by this geographic rule and the international price of oil to calculate oil windfalls in affected municipalities.

In section 4.3, I explain the measurement of the main dependent variable: corruption. Thanks to an innovative policy experiment, Brazil has some of the best micro-level data on actual corruption levels available for research. In 2003 the auditing agency (CGU- Controladoria-Geral da Uni ao) began randomly selecting 50-70 municipalities with a population of less than 500,000 to be audited[12]. In this dissertation, I use data from the random audits described above to construct a dataset that contains corruption measures between 2000 and 2017. My measure is most similar to Brollo et al. (2013), who create a corruption variable which identifies the fraction of audited funds which were involved in corrupt acts. The randomization of the audits eliminates any bias in the measure of corruption which could result from selection of municipalities into the auditing process. I then go on to describe the rest of the data which will be used to test the empirical implications of the theoretical model.

In Chapter Five, I present the reduced form results. Throughout the statistical tests, I find strong empirical evidence for the theoretical predictions of my model. Consistent with the theory, I find that municipalities that receive large offshore windfalls display higher levels of corruption on average. These effects are large and statistically significant. Everything else equal, I find that a one

[12]This population threshold has varied through time

standard deviation increase in oil royalties leads to a 29% increase in the amount of funds found to be linked to corruption. Additionally, I find that these effects follow the international price cycle as predicted by the theory. Corruption in oil affected municipalities is higher in terms after a boom election, while it is lower in terms after a bust election. These effects are also large and similar in magnitude to the average effect of oil on corruption. As predicted by the theory, oil windfalls lead to higher reelection rates for incumbents running for reelection during booms and lower reelection rates for incumbents running for reelection during busts.

Additionally, I provide some evidence of the downstream effects of oil windfalls on spending outcomes. I find that windfall affected municipalities spend more on housing and infrastructure investments and less on health and education, which indirectly supports the finding that windfall affected municipalities engage in more corruption. Finally, I test for alternative mechanisms such as informational effects, and I do not find support for this alternative hypothesis. In fact, access to more information only reduces corruption outcomes for second term mayors, where my theory would predict that moral hazard is the most important mechanism. Taken together, the results in this chapter provide strong empirical support for the theory proposed in Chapter 3. I find that oil windfalls significantly reduce voters ability to hold their politicians accountable, and lead to higher reelection rates, corruption and more venal candidates running for office during booms. Oil windfalls also lead to important policy distortions which are likely part of the reason why oil municipalities have not been able to improve their socio-economic indicators despite the large amounts of funds available at their disposal.

In Chapter Six, I use a calibration exercise to identify the unobserved parameters, and also run some counterfactual exercises. The quality of candidates, crucial for the entry mechanism proposed in the theory, is by definition an unobserved trait, and furthermore, it is confounded by both a candidate's decision to pool and the voter's decision on whether or not to reelect the incumbent. This means that reduced form techniques are not well suited to estimate such a parameter. Thus, I first present some suggestive evidence based on reduced form findings which indicate that the entry mechanism might be at play. Then, to estimate the role of hidden actions (moral hazard) and hidden

types (adverse selection and entry into politics), I use the structure of the model and simulated data in a calibration exercise. Since candidate type and pooling decisions are unobserved in the data, I solve the model on simulated data where types are drawn from a known distribution and use this to recover latent moments for candidate type, whether incumbents are pooling or not and the average type of the pool of candidates. In this chapter I show that if we dont consider the entry effects driven by windfalls, we might actually miss more than 40 percent of the effects of windfalls on corruption. The effects windfalls have on shaping the political class are important and substantial in size, especially during a period of successive boom elections where we can see the political class significantly deteriorate. In this sense, putting an emphasis on the role that commodity windfalls can have on the quality of the political class is a key topic to consider when thinking about the detrimental political effects of the resource curse.

Finally, in Chapter Seven, I conclude by considering further research that could stem from this work, considering how these findings can be applied to other contexts with similar characteristics and also suggesting possible policy implications. Countries like Peru, Ecuador, Colombia and Bolivia all have similar royalty distribution schemes for either oil or mineral exploitation, and thus are likely to be exposed to the same cyclical shocks I have outlined here for Brazil. Countries like Guyana and Suriname, which have recently discovered huge oil reserves stand to benefit a great deal from the lessons learned here as they design the institutions surrounding their newfound oil wealth and decide on the way they will distribute this prosperity. A possible way of preventing the break in accountability caused by the cyclical shocks generated by resource windfalls could be to isolate governments from the large fluctuations in windfalls caused by resource price volatility. Sovereign wealth funds and anti-cyclical fiscal rules are some of the ways in which this goal can be attained, and might be an effective way to address the negative consequences produced by these windfalls and achieve better governance.

2 Oil, Corruption and the Types of Politicians Who Run for Office

The resource curse has been well studied by political scientists. Scholars of comparative politics have focused on whether natural resources enhance the stability of autocratic regimes. However, we know much less about how natural resources affect the quality of democracy within democratic regimes. In particular, natural resources might lead to higher levels of corruption. Although there has been work linking natural resources to corruption, the mechanisms through which these windfalls lead to higher levels of malfeasance are still understudied. Natural resources are thought to lead to higher corruption due to a lack of transparency and high volatility of the income generated from their extraction. In this chapter I outline the ways through which natural resource windfalls might affect actors' incentives and thus lead to higher corruption and lower accountability.

Consider the case of Brazilian municipalities. The oil discoveries off the coast of Brazil promised to be an economic bonanza which would propel its citizens out of poverty and fund major investments that would lead to significant improvements in living standards. The huge increase in oil production due to discoveries of offshore oil reserves meant that Brazil would see a significant increase in cash entering into the government's budget. As described in Chapter 4, about 35% of the total amount of royalties generated by oil exploration was distributed directly to municipalities affected by oil extraction. These local governments had almost total discretion over how to spend

these large sums of money[1]. Many of these municipalities were very poor before the onset of the windfalls, which in some cases led to a doubling, tripling or quadrupling of the amount of resources available in the municipal budgets. However, twenty years in, most of these places remain poor despite the large cash windfalls received by their governments.

The case of Presidente Kennedy is emblematic. This small municipality off the coast of Espírito Santo has been one of the highest royalty receivers in the past twenty years. This has made it rank first in terms of municipal government revenue per capita many years in a row. However, only 38% of its residents have access to clean water and sewage systems and only 10% of its roads are paved. Additionally, about half of the municipality's population is dependent on some type of federal program like Bolsa Família, and the municipality ranks in the lower half of the distribution in terms of child mortality and educational attainment. How is it that the richest municipality in revenue per capita terms has such negative socio-economic indicators?

One possible answer to this question is corruption. Since 2001, all of its elected mayors have been investigated in relation to corruption scandals. Examples of malfeasance in this small town include illegal procurement processes where the winners of the contracts were colluded with the government, over-invoicing in education and health expenditures as well as construction projects, the hiring of "ghost" firms for activities which are not disclosed in the government budget and nepotism. However, during the boom of oil royalties, these corrupt incumbents were repeatedly reelected to serve a second term. In other words, voters were unable to use elections to vote out corrupt incumbents.

This case raises several interesting questions: (1) Have the enormous oil windfalls led to the proliferation of corruption and political turmoil this municipality has experienced in the last 20 years? 2) Why have voters not been able to hold their mayors accountable, at the very least by voting them out of office when they engage in corruption? 3) Why have we seen a sustained

[1]The only restriction was that the royalties could not be spent on debt payments or on permanent staff's salaries. In 2013, Lei 12.585 was approved, which changed the rules for the expenditure of royalties. Under this new rule, royalties from contracts signed after December 2, 2012 had to be used for education (75%) and health (25%). However, given long lag times between date of contract signature and actual oil production, the first year that these royalties began to affect municipal budgets was 2018, which is outside the scope of this study.

deterioration in the kinds of politicians running for office in this municipality?

In this chapter I outline two of the main ideas proposed in this dissertation which seek to answer these three related questions. First, I discuss the role that natural resource windfalls and price cycles, specifically booms and busts, have on incumbent politicians' decisions about how much corruption to engage in while they are in office. Here, politicians are thought to be undertaking a calculus which compares the benefits of extracting as much as possible in the current period in the form of corruption versus extracting less in the effort to win reelection and thus hold office for a second period, where there will be new opportunities for rent extraction. This calculus will, consequently, be importantly affected by the price of oil which will determine the amount of royalties expected to flow into the municipal coffers in the following period in ways I will explore below.

Second, I examine how these price cycles affect the decisions of citizens to enter into politics, thus changing the quality of the politician pool in places affected by windfalls. This second mechanism considers all citizens as potential politicians, where the decision whether to actually become a politician or not will depend on the expected rent extraction possibilities that holding office would provide, as well as the expected wage outside of politics. Driven by the possibility of higher rent extraction, oil windfalls lead to more dishonest citizens entering into politics during booms, which compounds the effects of oil windfalls on corruption. Together, these two mechanisms lead to electoral and corruption cycles generated by oil windfalls.

My theory of resource windfalls and corruption can be understood in varying degrees of mathematical precision and generality. In this chapter, I present a descriptive framework which is relatively intuitive and example-based. A formal exposition is introduced in Chapter 3.

2.1 The Political Resource Curse

I argue that oil has a negative effect on specific aspects of the quality of democracy, in particular with regards to accountability and corruption. So far, the literature has not been able to explain

these differences in institutional quality within democracies that are mineral rich. The existing literature suggests that oil wealth has negative effects on a country's economy and governance. Although it may seem counter intuitive that ownership of a valuable natural resource generates adverse effects on a country's economy, the finding that oil has a negative impact on growth and democratic emergence and stability has been quite robust (Ross 2015). The first proponents of the idea coined the term Dutch Disease, whereby favorable conditions in the export commodity, such as a new discovery or a price increase, distort the overall economy by appreciating the real exchange rate and making other exports such as manufactures and agriculture less competitive (Corden and Neary 1982; Neary and van Wijnbergen 1985; Roemer 1983).

On top of this negative economic outcome, the literature has also identified negative political outcomes such as leader survival (Aslaksen 2010; Andersen and Aslaksen 2013), and the quality of democracy and likelihood of democratic transitions (Tsui 2011; Andersen and Aslaksen 2013; Gassebner et al. 2013). Alternatively, institutional quality at the time of the discoveries also matters when determining the effect of the discovery on the economy (Dunning 2008; Andersen and Aslaksen 2013). Politics matters, and so resource curse literature has had to account for the effects of resource shocks on institutions, as well as internalizing how political factors can mediate the negative economic consequences of the Dutch Disease. This new branch of the literature has been termed the "Institutional Resource Curse".

Empirical support for the "Institutional Resource Curse" has been found in many cross-country studies (Sachs and Warner 1995, 1999; Isham et al. 2005; Mehlum et al. 2006; Karl 1997; Ross 2001; Ahmadov 2014). The strongest effects found indicate that the negative effect of oil on democracy is through the prolongation of autocratic survival: oil entrenches autocrats and makes democratic transitions less likely (Cuaresma et al. 2011; Andersen and Aslaksen 2013; De Mesquita and Smith 2010; Egorov et al. 2009; Gandhi and Przeworski 2007; Wright et al. 2013). The relationship between oil and democracy is less straightforward. Some propose that oil has pro-democratic effects (Smith 2004; Dunning 2008; Morrison 2009; Tsui 2011), while others argue that there is no effect of oil on democracies, and that the relationship arises merely

through stabilizing autocratic rulers' tenure (Caselli and Tesei 2011; Wiens et al. 2014; Andersen and Aslaksen 2013).

Mehlum et al. (2006) find that the direct negative effect on growth (once you control for the interaction between resource endowment and institutions) is stronger for minerals than for resources in general, and that institutions are more decisive for minerals than for other natural resources. Others have challenged this view, proposing that there is a conditional effect of oil on democracy, depending on levels of inequality Dunning (2008).

Along the same line, Isham et al. (2005) find that countries with more endowments of point-source natural resources have weaker institutions, and that these have affected growth levels since the oil shock in the 1970s. Ross (2001) uses panel data to identify a negative effect of oil exports on democracy, using 5 year lags in the explanatory variables to ascertain some form of causality. The link between oil rents and democracy was further established in a meta-analysis of the results of 29 studies, finding that there is a negative, statistically significant and robust negative effect of oil on democracy (Ahmadov 2014). Dunning (2008) makes a conditional argument, oil wealth prevents democratic transitions in fairly equal societies, while it makes democratic transitions more likely in highly unequal societies since elites have less incentives to block the transitions. The driver of this argument is the assumption that oil wealth will lead to lower taxes under democracy, so the elites fear lower expropriation risks when their country has large oil income.

While the finding on the negative effects of oil on democratic transitions seems to be a robust an important one, it is likely missing important variation on the quality of the institutions in the countries it deems democratic. Additionally, conditional arguments like that proposed by Dunning (2008) also map on to coarse measures of democracy, that do not capture much nuance in the quality of domestic institutions. It is far more probable that the effects of oil rents can be better seen when analyzing narrower measures for the quality of democracies, such as checks and balances, government accountability and corruption. This is especially interesting when we move away from the cases in the Middle East and towards more complex cases of resource rich countries such as Venezuela, where the country remains "democratic" on paper and on the widely used Polity

IV indexes, however there has been a significative reduction of checks and balances, a spike in corruption and a complete mismanagement of the economy.

In general, resource rich and especially oil rich countries in Latin America remain "democratic" on paper, however, the quality of their democracies has suffered seriously. Beginning in the late 1990s, Venezuela, Bolivia and Ecuador (the three main oil exporters) began a process of dismantling checks and balances, passing constitutions that seriously concentrated power on the executive (Acemoglu et al. 2013). Additionally, Venezuela, Ecuador, Brazil, Argentina and even Chile have seen scandalous episodes of corruption following a period of high oil, gas and mineral prices. So while Dunning (2008) finds a positive effect of oil on democracy in these places, I argue that oil has a negative effect on the more nuanced measures for quality of democracy, in this case, corruption levels and quality of candidate pools. So far, the literature has not been able to explain these differences in institutional quality within democracies that are mineral rich. Oil windfalls may not change whether a democracy breaks down or not, but they do affect more narrow institutional outcomes such as accountability, corruption levels and the quality of politicians running for office.

2.2 The Link Between Natural Resources and Corruption

While the causes of corruption have been widely studied (for comprehensive surveys see Svensson (2005), Treisman (2007), Golden and Fisman (2017)), the link between natural resources and corruption has been relatively understudied. Some work finds that natural resource wealth leads to more rent seeking behavior by economic elites as opposed to extractive corruption by politicians (Deacon and Rode 2012; Leite and Weidmann 1999) and the dynamic common pool resource models identify a similar effect related to the extraction of the resource (Lane and Tornell 1999; Velasco 1999). Bhattacharyya and Hodler (2010) develop a theoretical model with two types of politicians and show that higher levels of resource rents will lead to higher levels of corruption in weakly institutionalized countries. Their model does not consider the volatility of the resources or the incentives generated for more dishonest types to enter politics. They then test their hypothesis

on panel data and find a positive effect of resource rents on corruption using the Corruption Index from the Political Risk Survey. Similarly, Arezki and Brückner (2011) find that increases in oil rents significantly increase levels of corruption. They test this hypothesis using fixed effects estimation on panel data from 1992-2005, using the Political Risk Survey as a measure of corruption. Busse and Gröning (2013) find a strong and significant effect of oil exports on corruption, but not other governance indicators.

Most of these studies however, do not provide a strong causal identification. All of them rely on cross country regressions, where measures of corruption are riddled with issues and tend to better portray corruption perceptions rather than actual corruption (Treisman 2007). Furthermore, it is difficult to establish causal relationships using cross-national, reduced from estimates.

In addition, most of the previous literature focuses on levels of oil dependence. In this dissertation, I argue that the cyclical nature of oil revenues generates dynamic effects on both corruption levels and the quality of candidates that decide to run for office. The main idea is derived from the fact that expected income from natural resources in the future can determine the way incumbents act in the present, and can also create incentives for dishonest politicians to decide to run for office, if they expect that they will be able to extract more rents in the future. This line of research focuses on the micro-foundations of the political resource curse, honing in on the ways resource rents change individual's incentives and through their actions, institutional outcomes.

Studies of this type have found that incumbents incentives change in the presence of resource shocks (Caselli and Cunningham 2009; Carreri and Dube 2017; Bhavnani and Lupu 2016). Using reduced form estimates, some find that incumbent politicians redirect funds to less productive uses (Caselli and Cunningham 2009), others find an increase in patronage and clientelistic practices (Bhavnani and Lupu 2016), and another set of studies finds that different type of politicians (linked to paramilitary groups) comes to power in presence of these shocks (Carreri and Dube 2017). In mineral-rich regions of India, Asher and Novosad (2019) report that global price shocks lead to both incumbency advantages in local elections and more frequent victories by candidates with criminal records. Vicente (2010) shows that voters perceive the higher levels of corruption that take place

during an oil boom in São Tomé and Príncipe.

Ferraz and Monteiro (2014) look at oil royalties in Brazil between 2000 and 2008, and find that oil royalties generated an incumbency advantage effect only in the first term that a municipality received royalties, arguing that voters learn to disentangle the economic effect of the shock from the incumbent's performance. My dissertation provides an alternative mechanism to this argument, showing how price fluctuations generate dynamic incentives which can account for the cycles identified by Ferraz and Monteiro (2014). I also use elections between 2000 and 2016 to test my argument, and incorporate corruption data and cyclical, time varying effects into the theory. Furthermore, I show that the reduction in the effects of royalties estimated by them is likely due to the fall of oil prices during the 2008 election (the last election they consider), but the positive effects of oil on corruption show up again in 2012, so learning is likely not the mechanism that drove the reduction in the effect in 2008.

Theoretically, Brollo et al. (2013) is the closest study to this dissertation. The authors look at the effect of federal transfers to Brazilian municipalities on corruption levels. Their theory is based on a career concerns model with endogenous entry of candidates, where types are defined by competence and measured by years of schooling. They use a regression discontinuity design (RDD) to find that municipalities that received larger transfers had higher levels of corruption and candidate pools with lower average educational attainment.

Federal transfers, however, are not exogenous; rather, they are stable in time and are ultimately derived from taxes. The cyclical nature of oil is an important, and innovative aspect of my theory. Additionally, for Brollo et al. (2013), resource shocks deteriorate the quality of politicians as measured by their educational attainment. My argument is that this might not be the case since it is unclear whether educational attainment is negatively correlated with corruption. Because honesty is not an observable trait, the formal model and calibration exercise presented in Chapter 6 become an important part of the research design, since they allow us to estimate the candidate type from observed behavior. Finally, the sample in Brollo et al. (2013) is limited first by the number of municipalities for which they have corruption data and second by the conditions for the RDD where

only municipalities close to the population thresholds are considered in their estimation. Therefore, their estimates can only be thought of as measuring a local average treatment effect.

This dissertation uses a similarly motivated model of entry into politics but the expected future inflows vary in a cyclical way, which generates effects that are substantially different to those identified in Brollo et al. (2013). Below, I go through the intuition of the model which is presented more formally in Chapter 3.

2.3 Elections as a Principle-Agent Problem

Elections can be represented as a strategic game between citizen/voters and candidates, where citizen/voters are the principals who delegate representation and policy making power to their politicians, or agents. Elections in this setting should serve as an accountability mechanism, inducing politicians to be responsive to voters needs, as proposed by Besley: "When political authority is delegated to politicians, then they hold the public trust between elections. Constitutions offer only limited provisions for the control over politicians punishing them only for the grossest of abuses. The main sanction for poor performance is electoral, those who perform badly will not be re-elected. Hence, politics is about achieving accountability of politicians to voters." Besley (2006).

Under this framework, we assume that municipalities have a set budget which will depend on income from taxes and, in some places, royalties from oil. Voters are thus delegating responsibility over the expenditure of this budget to their elected politicians. Voters do not directly observe the budget and expenditure decisions, but they do observe public goods provision from which they can infer expenditure decisions.

Assume, for simplicity, that there is just one issue that voters care about: maximizing the amount of money that gets spent on public goods. This means that any amount of money a politician pockets will lead to lower voter welfare. Voters will thus seek to elect the most honest politician possible, who will spend the most amount of the available funds on public goods. Assume also, for simplicity, that politicians only differ on their degree of honesty, so there are no ideological

differences or differences in a politician's ability. This modeling decision follows a line of work where politician types differ with respect to their motivation for holding office (Besley and Case (1995a), Coate and Morris (1995), Fearon (1999) and Rogoff (1990)). Although assuming that voters dislike corruption explicitly would lead to similar results, the assumptions made here are more realistic in the sense that it is because voters care about public goods provision and government's ability to provide them with benefits that they care about, and make decisions based on beliefs about, corruption. In this sense, corruption is an issue insofar as it reduces voters welfare through its effect on public expenditure and public goods provision.

Throughout, we assume that honest politicians don't steal, while dishonest politicians want to steal as much as they can. Additionally, candidates will try to do everything they can to win elections and gain access to office. However, a politician's honesty is rarely a matter of public knowledge, and in fact politicians have strong incentives to portray themselves as honest, even when they are not. The voter is thus forced to choose whether to reelect an incumbent or vote for a challenger from the pool of candidates without perfect knowledge of the honesty of the incumbent or the challenger. The voter can observe the amount of public goods that the incumbent provided in the previous period, and use this to update her beliefs about whether the incumbent is honest or dishonest. Similarly, using her knowledge of the circumstances in her municipality, the voter will have some belief about the honesty of the challenger if she was to vote the incumbent out of office. This type of voting strategy where voters use past actions to update their beliefs using Bayes rule is a rational action by voters, since it is "precisely because there is information content in past actions about future behavior that retrospective voting is rational" (Besley 2006). In other words, given the information a voter has at hand, voting based on past actions is the best strategy a voter can pursue in order to maximize her welfare.

The voters best course of action is thus to compare her expected welfare if she were to reelect the incumbent vis a vis the expected welfare if she were to vote for a challenger, given her beliefs about each candidate's honesty. If the voter believes it is more likely that the incumbent is honest compared to the challenger, then the voter will reelect the incumbent. If, on the other hand,

she believes that it is more likely that the incumbent is dishonest compared to the challenger, she will vote the incumbent out and select a challenger from the pool of candidates.

In this effort, candidates can anticipate the way that voters will react, and thus change their behavior in order to maximize their chances of reelection. Incumbent politicians who are eligible to run for reelection may thus have an additional lever over which they can act upon in order to achieve their goal of winning the election, since they can use their term in office to provide voters with some information about their honesty. Namely, a dishonest politician can steal less money during his first term in office, in an effort to convince voters that he is in fact honest, and thus achieve reelection. Whether they engage in this type of behavior or not will depend on the relative gains from extracting less rents today and gaining access to future rents vis a vis extracting rents today and foregoing rents tomorrow.

This type of model which includes hidden action, incumbent politicians can engage in corruption without voters directly observing this, and hidden type, voters do not know whether the politician is honest or dishonest. This type of models which combine hidden action and hidden type were pioneered by Banks and Sundaram (1993) and Austen-Smith and Banks (1989). Applied to this setting, elections serve the two key roles of: (i) creating incentives to reduce corruption, and (ii) selecting the best candidate, in this case the most honest candidate.

This type of model can easily be applied to the study of Brazilian municipalities. In Brazil, mayors can serve up to two consecutive terms in office. Furthermore, corruption is a widespread phenomenon in local Brazilian politics. It is not unlikely that incumbents can engage in hidden actions such as embezzlement and that voters have uncertainty over the honesty of politicians. This means that a first term incumbent is eligible to run for reelection and can thus use his position in office to signal to voters that they should reelect him. On the flip-side, voters can use the threat of voting an incumbent out of office to induce the incumbent to behave in a way that is in accordance with the voters preferences. In this way, elections can serve as an accountability mechanism through which voters align the behavior of incumbents with their preferences through the promise of reelection (or the threat of losing office).

2.4 How Oil Windfalls affect the Principal-Agent Problem

How do windfalls change the actors' decisions? Oil windfalls represent a substantive shock to the municipal budget, sometimes doubling or even tripling the income for these local governments. Additionally, the amount of resources which will enter into the budget each period depends directly on the international price of oil, which is highly volatile. Oil windfalls thus create large fluctuations in the amount of resources these governments will have access to each period. These characteristics make oil windfalls distinct from other sources of income which are more stable and predictable. Thus, these windfalls affect actors' decisions in specific ways. First, larger flows of cash into municipal coffers generate more opportunities to embezzle funds. Additionally, the shock generated by these windfalls creates a noisy signal to voters, making it more difficult for them to differentiate honest types from dishonest ones.

Oil windfalls can thus change the calculus made by incumbents when deciding how much to steal in their first period. Dishonest politicians face a tradeoff when in office: if they steal too much, they reveal to voters that they are dishonest. Voters, in turn, will prefer to elect a challenger from the pool of candidates than an incumbent they now know to be dishonest, thus making rents in the second period unavailable for the incumbent to extract from. This means that under some circumstances, the dishonest politician may have incentives to steal less in his first term in office, in order to pretend that he is honest (pool with the honest type), and thus ensure reelection. If he manages to get reelected, he will then have access to extract rents in the next period.

Oil windfalls play an important role in this calculus. When expected future rents are very high, the incentives for a dishonest politician to pretend to be good and get reelected are also high. On the other hand, if rents are expected to plummet in the next period, it may be worthwhile for the dishonest incumbent to steal as much as possible in the current period, even though he will not get reelected. This will be the case when expected rents in the following period are so small that they cannot make up for the rents he would have to forego in the current period in order to win reelection.

During booms, or periods where future rents are expected to be significantly higher than current rents, the incentives for dishonest incumbents to behave as if they were honest is very large. This is due to the expectation of more embezzlement opportunities in the future, which makes the foregone rent extraction today "worth it" in the calculus of the incumbent. This leads to the reelection of more corrupt types during periods when the expected future price of oil is high, and subsequent higher levels of corruption in oil affected municipalities when these dishonest types hold office without the possibility of reelection, thus extracting as much rents as they can. Note that, although these dynamics lead to the reelection of more corrupt candidates, it is still a good idea to re-elect politicians on the basis of their first period behavior since expected performance among the pre-selected group of surviving period two politicians is higher than a randomly selected politician from the pool of candidates.

The opposite dynamics happen during bust periods, or periods where the expected rents in the future period are significantly lower than the current rents. In these periods, since future extraction opportunities are very small, it may be in the dishonest incumbent's best interest to steal as much as he can today, even if this reveals to voters that he is dishonest and thus leads him to loose reelection. This is because the amount of rent extraction he would have to forego in the current period would be larger than the amount that will be able to extract in the following period. Thus, reelection loses value to the incumbent and he will try to extract as much rent as possible in the current period. Here, given the low rents that reelection grants an incumbent, elections loose their incentive role, and thus more corruption in the first period will happen. However, this will also lead to the election of more honest types and so the following period should have lower rates of corruption.

2.5 How Windfalls Affect the Quality of Candidates

Oil windfalls might also affect actors decisions by changing the decision of citizens to run for political office. Since oil windfalls change the budget constraints for politicians in office, they

significantly change the extraction possibilities an incumbent has access to once they are elected into political office. In this sense, for dishonest individuals, the value of holding office is greatly affected by these windfalls, and so decisions to enter into politics may also be affected by these shocks. If dishonest individuals' incentives to enter politics are differentially affected as compared to honest politicians, we should expect the pool of candidates in oil affected places to look quite different to that in places where there are no windfalls from oil.

In order to conceptualize this, I follow Besley (2006b) and assume that the winning politician is randomly selected from a pool of candidates composed of individuals who have decided to enter into politics. Of course, this abstracts away from candidate selection processes such as party selections, campaigning and campaign finance decisions. However, it provides a simple way to understand the main effects of windfalls on citizens' decisions to enter into politics and thus the way in which windfalls might change the quality of the pool of candidates.

Assuming that every citizen has an intrinsic type (honest or dishonest) and that each person knows his own type, we can think of a society as having an average level of honesty. In the simplified version of the model without entry, which I discussed in the previous section, we could think of the honesty in the pool of candidates as being the same as the average honesty of people in that society, so that if a society contains more honest individuals, I would be more likely to elect an honest politician to office than if the society has more dishonest individuals.

However, once we allow for citizens to make decisions on whether to enter into politics or not, we must take into account the fact that honest types have different incentives than dishonest types. Specifically, the large inflows of money into government coffers shouldn't directly affect honest citizens' decision to enter into politics since they don't care about rent extraction opportunities. On the other hand, these large sums of money represent an enormous incentive for dishonest individuals to enter into politics, since they provide huge rent extraction opportunities. In an interview with the Treasury Secretary of an oil affected municipality during fieldwork conducted in 2018, he said: "*Everybody wants to run for office now that money is flowing*"[2] Additionally, the volatility in the

[2] "*Todo mundo quer se candidatar agora que o dinheiro ta rolando.*" Anonymous, Treasury Secretary from an oil affected municipality in the State of Rio de Janeiro.

cash inflows means that oil affected municipalities will see fluctuations in the quality of the pool of candidates which will depend on the future embezzlement opportunities.

Since voters decisions to reelect an incumbent depend on their belief that the incumbent is honest compared to the belief that the challenger will be honest, these changes in the quality of the pool of candidates have important effects on voters decisions to reelect. In this sense, if voters believe that the probability of selecting an honest politician from the pool of challengers is smaller than the probability that the incumbent is honest, then they will decide to reelect the incumbent. If they believe they are more likely to select an honest challenger, then they will choose to vote the incumbent out.

In the case of oil affected municipalities, periods of booms will attract more dishonest citizens into political careers, generating an additional effect on the reelection of dishonest types in office. From the perspective of a dishonest person considering whether she wants to run for political office, there are greater incentives for her to enter politics when the expected future inflows are high, since she can expect more extraction opportunities. This leads to more dishonest citizens entering into politics in places affected by oil windfalls during boom periods, which in turn creates an extra pressure to reelect the incumbent because the voter's expectation of selecting an honest candidate from this pool of candidates which is now filled with dishonest people is smaller.

On the other hand, during busts, the prospect for very low rent extraction in the future period makes dishonest citizens who are evaluating whether to enter into political office less inclined to do so. The pool of candidates will therefore be on average more honest than during booms. This means that during busts, fewer corrupt types will be reelected since voters have more incentives to go back to the pool of candidates and select a fresh incumbent. Thus, corruption in the following period will be lower, since on average more honest types will have been elected into office from the pool of challengers. Municipalities that are not affected by oil windfalls display significantly less volatile and more stable finances, and are thus not subject to these booms and busts in the ways which oil municipalities are.

2.6 Windfalls Lead to Corruption/Reelection Cycles and a Deterioration of the Candidate Pool

Taken together, the effects of windfalls on the principal-agent problem and on the decision of citizens to enter into politics lead to certain predictions about the effects of windfalls on corruption rates, reelection rates and the honesty of candidates that run for office in oil affected places.

Given the overall negative effect of oil on accountability, windfalls are expected to raise corruption in affected municipalities on average. However, the theory also generates predictions that are more complex and dynamic in nature: corruption will respond to the international price cycle, generating cycles of corruption. The corruption cycles are driven in part by differential incentives for incumbents to pool during booms versus busts, and in part by differential incentives for dishonest incumbents to enter into politics during booms versus busts. Table 2.1 shows the predicted effects on incumbent reelection rates, entry of venal types and corruption outcomes depending on whether we are in a boom or bust period.

As outlined above, boom periods lead to: (1) more dishonest incumbents stealing less in an effort to win reelection and (2) more dishonest candidates entering into politics, attracted by the possibility of high rent extraction. The combination of these two dynamics leads to more dishonest incumbents being elected during boom periods, which then leads to higher corruption in periods following a boom election. This means that for elections held during booms, we expect to see higher reelection rates and more dishonest candidates running for office in oil affected municipalities. During periods after a boom election, we expect corruption to be higher in oil affected municipalities.

During bust periods, we expect to see: (1) dishonest incumbents stealing more in the current period, since they will not put as much effort into getting reelected, and (2) fewer dishonest candidates running for office, since the opportunities for rent extraction are no longer as significant. The combination of these two dynamics leads to fewer dishonest incumbents being elected during bust periods, which then leads to lower corruption in periods following a boom election. This

Table 2.1: Effects of Oil Windfalls on Corruption, Reelection and Candidate Entry

	Booms	**Busts**
Incumbent Reelection	Will to steal less to gain reelection More corrupt incumbents reelected	Will steal more and loose reelection Fewer corrupt incumbents reelected
Entry	More corrupt candidates enter	Fewer corrupt candidates enter
Corruption	Corruption goes up second term	Corruption goes down second term

means that for elections held during busts, we expect to see lower reelection rates and less dishonest candidates running for office in oil affected municipalities. During periods after a bust election, we expect corruption to be lower in oil affected municipalities.

To exemplify these dynamics, let us go back to the example of Presidente Kennedy. In 2000, Aluízio Carlos Correa was elected into office amid an oil boom. He was reelected into office in 2004 during a second boom election. However, after his second term in office, he was prosecuted in 2012 for acts of responsibility and corruption. During his last year in office, 2008, he used municipal funds to hire lawyers for services that were never rendered, as well as using funds for private ends. He was sentenced to six years in jail.

In 2008, Reginaldo dos Santos Quinta was elected into office. He remained popular throughout his term and was reelected for a second term in 2012, during a period of significant expansion in royalties received by the municipality of Presidente Kennedy. However, during his second term he was plagued by accusations of corruption, and was removed from office before he could finish his term. A quick search of his name in the Jusbrasil website (a website which searches through all legal processes started against/by a person in Brazil) comes up with a staggering 21 active processes against Reginaldo dos Santos Quinta, 12 of them from the TJES (Espírito Santo Judicial Tribunal - Tribunal Judicial do Espírito Santo) and 4 of them by the STJ (Superior Justice Tribunal - Superior Tribunal da Justiça)[3]. Although some of the processes involve acts of malfeasance which occurred during his first term, most of the acts uncovered are concentrated during his second term in office. Reginaldo dos Santos Quinta, a clear example of a dishonest type, managed to get reelected during a boom election in his first term and fully revealed his type in his second term, engaging in as much

[3]https://www.jusbrasil.com.br/processos/nome/75004921/reginaldo-dos-santos-quinta

corruption as he was able to.

Another example of the dynamics explained above can be seen in the municipality Rio das Ostras, in Rio de Janeiro. In 1996, Alcebíades Sabino dos Santos was elected into office in this small municipality in Rio de Janeiro. In 2000, amid a large increase in royalties in his municipality, he enjoyed high approval ratings and was reelected into office for a second term. However, several processes have uncovered significant corruption during his second term. The charge that eventually led him to be sentenced was one identified in the CGU audits, where he was found to be emitting over-invoices of up to 3,800% in the purchase of important medicine. Alcebíades Sabino dos Santos, another corrupt incumbent, was reelected during a boom election and fully revealed his type while in office his second period, engaging in corruption which would only be uncovered and prosecuted 7 years later. A search of his name in Jusbrasil uncovers 92 processes against him. 88 in the TJRJ (Rio de Janeiro Judicial Tribunal - Tribunal Regional do Rio de Janeiro) and 3 in TRF2 (Regional Federal Tribunal of the 2nd Region - Tribunal Regional Federal da 2a Região).

On the effect of busts, we can take the case of Saquarema, a municipality with a population of about 75,000 in Rio de Janeiro. Antonio Peres, the incumbent mayor was re-elected in 2004, during a boom. He was involved in the large and very public corruption scandal known interchangeably as "Operação Sanguessugas" (Operation Leeches) or "Máfia das Ambulâncias" (Ambulance Mafia). This corruption scandal involved the purchase of more than 1,000 ambulances through corrupt procurement processes and with over-invoicing of up t 260% the market value of the ambulance. He was also involved in the illegal concession of several large plots of land. Most of his malfeasance happened during his second term in office. This is a clear example of a dishonest politician who gains reelection during a boom election, only to ramp up his malfeasance during his second term in office.

In the 2008 election, Franciane Motta (also known as Franciane Melo after her husband's name) was elected mayor of Saquarema. The theory would predict that selecting a candidate from the pool would lead to a higher chance of electing an honest type. Franciane, proved to be a very successful mayor, despite the fall in oil royalties her municipality experienced: she won reelection

in 2012 with over 63% of the popular vote, obtained absolute majority for her coalition in the city council and had high approval indices throughout her two terms in office. During her term in office, she built or reformed 38 schools and childcare facilities serving 13,000 children, invested in providing school meals in the public schools, built a new hospital, and invested heavily in the re-urbanization of the industrial center of the city. She then went on to be elected as State Deputy of Rio de Janeiro. Of course, this case would be even more illustrative if Antonio Peres were able to run for reelection in 2008, and had lost to Franciane. However, his ineligibility to run makes it difficult to know what would have happened had he run. If we were to take the theory seriously, we would have expected him to steal lots in the 2005-2008 period, run for reelection and loose. However, the election of a more "honest" candidate during the crisis period is in line with the predictions of the model.

Maricá is another municipality which follows a similar pattern to Saquarema. Although the incumbent mayor could not run for reelection in 2008, it is unlikely he would have won and he was plagued by corruption scandals. Instead, in 2008 the people of Maricá elected Washington Quaquá (whose full name is Washington Luiz Cardoso Siqueira). He enjoyed widespread support and popularity and easily won reelection in 2012. During his terms in office, Maricá became the first city with more than 100,000 inhabitants to adopt a free public transportation program, which was fully financed with royalties from oil and spearheaded by Washington Quaquá.During his term in office, Maricá also created an innovative new social currency called Mumbuca, an electronic mone system created in 2013 with the intention of diminishing poverty through direct government transfers without leading to inflation. This currency is only accepted in local comercial establishments and is controled by the Secretaria de Economia Solidária e Combate à Pobreza (the Secretariat for the Solidarity Economy and the Combat of Poverty).[4]. In the 2016 election, also considered a bust election, Maricá elected Fabiano Horta, another mayor who has been responsible for a revolutionary program which is using royalties to provide Universal Basic Income to its citizens through the

[4]Washington Quaquá has since been investigated for abuse of political force, but was never removed from office or fully charged. This makes it a gray area when thinking about whether he can be considered an honest type or not, but at least the quality of life in Maricá has improved significantly since 2008, far outpacing some of its neighboring royalty receiving municipalities which have lagged far behind.

Mumbuca currency. The program has been rolled out in conjunction with the Federal Fluminense University and the Jain Family Institute, where they are looking to evaluate the program which is funded by income from oil royalties. Fabiano Horta also enjoys widespread support and won reelection in 2020, beginning his second term in January 2021.

These examples display the widespread effect of oil royalties on corruption in municipalities that have been made rich by these exogenous windfalls. They also display how mayors who are corrupt manage to gain reelection in these places, only to then ravage municipal coffers during their second term in office.

This theory not only helps explain the observed reelection cycles in commodity dependent countries across the world, where incumbents get reelected during booms and are voted out during busts (Campello and Zucco Jr. 2016), but also helps explain corruption outcomes and differences in the quality of the pool of candidates between royalty receiving and non-royalty receiving places which should change depending on whether the commodity prices are rising or falling.

The general theoretical framework I will develop in the following chapter helps us mathematically understand the relationship between resource windfalls and political corruption. The model provides the micro-foundations for the mechanisms through which resource windfalls affect elections, corruption and the integrity of the political class. It shows that selection into politics is driven by embezzlement opportunities, which natural resource windfalls alter by changing incumbents budget constraints and obscuring voters evaluation of their performance. As such, these resources create incentives for dishonest candidates to enter politics, which in turn generates reelection and corruption cycles which follow the commodity price cycles. A key implication of the theory is not only that more money is associated with more corruption; but, more importantly, that fluctuations of the revenue flows play a central role in shaping the integrity of the political class.

3 A Formal Model of Oil Windfalls and Corruption

In the previous chapter I presented an intuitive and example-based framework for understanding how oil windfalls can affect corruption, reelection and the quality of the candidate pool in oil affected municipalities. This theme is developed further in this chapter with the introduction of a relatively simple mathematical model. Its main goal is to shed light on the mechanisms through which natural resource windfalls can change the local political dynamics leading to corruption and reelection cycles.

The framework is based on a simple model of political agency by Besley (2004). The model shows how oil shocks affect corruption levels through three channels: (i) ex ante selection: oil shocks affect the type of politician who decides to run for office; (ii) moral hazard: oil shocks affect the incentives politicians have while in office; and (iii) ex post selection: oil shocks can affect the capacity of voters to evaluate politician type and select good politicians.

In the model, politicians can serve a maximum of two terms. In period 1, a randomly chosen incumbent sits in office and voters do not know his type. Elections take place at the end of each period, $t = 1, 2$. Politicians can either be honest (g) or corrupt (b) types, such that politician $i \in \{g, b\}$, and $Pr(g) = \pi_1$, denotes the probability that a randomly picked incumbent will be honest in period 1. For now, $\pi_1 = \pi_2$, and they are exogenous. Later I endogenize entry into politics, so π_2 will vary with the proportion of honest types that enter politics. Note that this is a particular example of a model that mixes moral hazard and adverse selection, where the types vary based on

motivation, rather than ability (Besley 2006).

The Politicians' utility functions are such that $U_t^i = R_t + (1 - c^i)s_t$, where $c^g = 1$ and $c^b = 0$, the honest politician cares about his ego rents and salary from being in office, R, while the corrupt politician cares about being in office and his rents, $s_t + R$. We can think of c_i as a morality cost of stealing, where this cost is prohibitively high for honest types, making them never want to steal, while it is very low for dishonest types, making them want to steal as much as possible. A possible extension of this model would be to vary these costs which could depend on legal conditions such as the likelihood of getting caught, the likelihood of getting prosecuted or the harshness of the punishment. For the purposes of this model, we simplify and assume these very discrete moral costs which differentiate honest from dishonest types.

During their first period in office, incumbents must decide how to allocate the funds they receive from taxes and federal transfers, x_t, and from oil royalties, Ω_t. Incumbents can use these funds to provide public goods, at a cost θ_t or to extract them as rent, s_t. This θ_t represents a variable cost determined by nature which only the politician can observe, leaving the voter in the dark about the state of the world. For purposes of making the model more realistic, I impose a maximum amount of rent extraction $\bar{s}$, which can be interpreted as a level of rent extraction that would inevitably land the politician in jail. This is another possible place where we could introduce legal conditions described above into the model, i.e. if punishments are harsher or likelihood of getting caught is higher, then $\bar{s}$ should be set lower, meaning the politician can steal less at the extreme.

The cost shock, θ_t can either be high or low, $\theta_t \in \{L, H\}$, and $Pr(\theta_t = H) = q$, where q denotes the probability that θ_t is high. We can think of θ_t as a random cost shock. When it is high, the cost of providing public goods is higher for the politician, making him able to produce less public goods with the same amount of money. When it is low, the cost of providing public goods is lower so the same amount of money can produce a larger amount of goods for the public. Thus, the politician's budget constraint is given by:

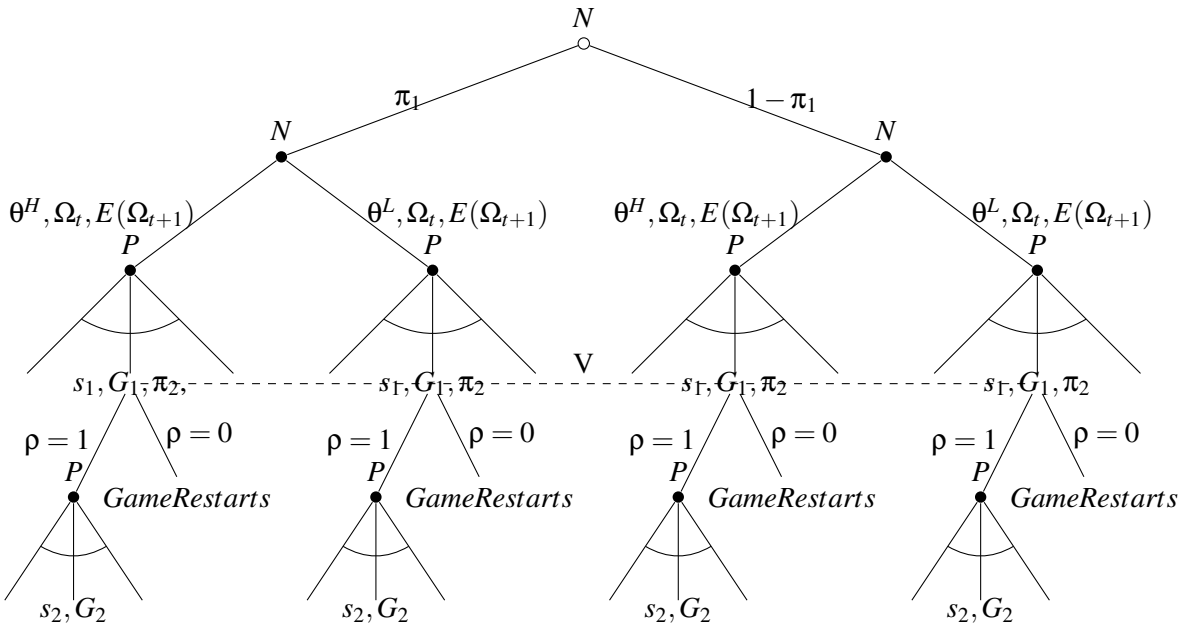


Figure 3.1: Extensive-form Game

$$\Omega_t + x_t = \theta_t G_t + s_t \tag{3.1}$$

The two components of the government income follow different distributions in time, with x_t being a very stable and predictable source of income, and Ω_t representing a cyclical and unpredictable source of income, subject to strong external shocks determined by the international price of oil. Throughout the model, this feature of Ω will drive many interesting results.

Each period, nature determines the state of the world (realization of θ_t and Ω_t) and type of the politician if the incumbent is not reelected. The elected politician then chooses his preferred actions, G_t and s_t. Voters observe their welfare, $W_t = G_t^k$, where $k < 1$. Voter's utility is a concave function of G_t, which means that there are diminishing returns to public goods provision. Once voters observe their welfare, they decide whether to re-elect the incumbent or vote him out, randomly choosing a politician from the pool of challengers.

An equilibrium in this model is a series of actions and voting behaviors such that voters use Bayes' rule to update their beliefs on the type of politician, and both voters and politicians optimize.

3.1 Equilibrium Behavior

In order to find the equilibrium behavior of the actors, we must consider what their best strategies are given their preferences and constraints. Honest politicians will never steal, so their equilibrium behavior for both periods will be $s_t^g = 0$ such that $G_t = \frac{x_t+\Omega_t}{\theta_t}$. This means that in the first period, an honest incumbent will not steal at all, and instead will spend all of the budget on public goods. The total amount of public goods, G_t, will depend on the total amount of money available to spend, $x_t + \Omega_t$, as well as the state of the world determined by θ_t.

The behavior of the corrupt politician is more interesting. To solve his optimal strategy, I use backwards induction. A corrupt politician in his second period, $t = 2$, has no incentives to pretend to be an honest politician because he cannot be reelected for a third period. Thus, in his second period, his optimal strategy is $s_2^b = \bar{s}$ and $G_2^b = \frac{x_2+\Omega_2-\bar{s}}{\theta_2}$. This means that in his second period he will steal as much as he can, $\bar{s}$, and spend the rest on public goods.

In his first term, the calculus is a bit more complex. The politician could steal as much as possible, but then he would reveal to the voter that he is a dishonest type and would not get reelected. On the other hand, the politician could pool with the honest type in an effort to convince the voter that he is honest, and thus win reelection, gaining access to the second period rents. A corrupt politician only has incentives to pool with the honest politicians if this will increase his chances of reelection, thus allowing him to steal in the second period. In other words, a dishonest politician will only benefit from pooling if pooling will convince the voter that he is an honest type.

This is only true during periods where $\theta = L$. Given the cost shock, $\theta_t \in H, L$, we can see that $G_t(\theta = H) = \frac{x_t+\Omega_t}{H} < G_t(\theta = L) = \frac{x_t+\Omega_t}{L}$, so public goods provision will be higher during periods where the cost is low. Since θ is not observed by voters, a corrupt politician with a realization $\theta = L$ can pretend to be an honest politician with a realization $\theta = H$. This would lead to higher chances of him being reelected, as well as him being able to steal a bit in period 1, and a lot in period 2. Under these circumstances, an incumbent can steal $s_b^{L_p}$, the amount a bad type can steal when the cost shock is low and he is pooling, which is defined by:

Table 3.1: Equilibrium Conditions

Equilibrium Type	Behavior	Conditions: Exists iff
Pooling Equilibrium	$\lambda = \sigma = 1$	$q \geq \frac{1}{2}$ & $s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) \geq x_1 + \Omega_1 + R_1$
Hybrid Equilibrium	$\lambda = \frac{q}{1-q}$; $\sigma > 0$	$q < \frac{1}{2}$ & $s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) = x_1 + \Omega_1 + R_1$
Separating Equilibrium	$\lambda = 0; \sigma = 1$	$s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) \leq x_1 + \Omega_1 + R_1$

$$s_b^{L_p} = \frac{(H-L)(x_t + \Omega_t)}{H} \tag{3.2}$$

or $s_b^{L_p} = \bar{s}$ if $s_b^{L_p} \geq \bar{s}$.

Let λ denote the probability that voters observe $G(\theta = H)$ given that the type was (b, L), such that $\lambda = Pr(G = G(H)|\theta = L, i = b)$. Once they observe public goods provision, voters will update their beliefs about whether an incumbent is honest or dishonest depending on what they observe. The bayesian updating that takes place is defined by:

$$Pr(g|G(H)) = \frac{\pi q}{\pi q + (1-\pi)(1-q)\lambda} = \gamma \tag{3.3}$$

In this scenario, voters will reelect an incumbent with a positive probability, σ, only when $\gamma > \pi_2$, which only happens when $\lambda \leq \frac{q}{1-q}$. Note that since a politician is rational and takes into account his opportunity cost, he will only choose to pool, so $\lambda > 0$, if $s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) \geq x_1 + \Omega_1 + R_1$. In other words, a politician will only choose to pool if the expected benefits from foregoing some rents in the current period in order to access rents in the future period are larger than the rents he could accrue from stealing as much as possible in the current period.

The dishonest politician thus has three choices when $\theta = L$: (1) he can pool with the honest politician, stealing a bit in period one in order to pretend to be good and ensure reelection and then extract maximum rents in period 2, (2) he can steal $\bar{s_1}$ and get voted out, or (3) he can pursue a mixed strategy equilibrium where with some probability he plays a pooling equilibrium and with some probability he plays a separating equilibrium.

The conditions under which the politician will choose each equilibrium are as follows:

Note here that very high expected future rents make it more likely for dishonest politicians

to want to pool, because they foresee the possibility of accessing large amounts of rents in the future. On the other hand, when future rents are small compared to current rents, dishonest incumbents will be more likely to extract as much as possible today, revealing their type to voters and creating a separating equilibrium, where honest types are reelected and dishonest types are voted out of office. One other thing to note is that if the politician is very impatient, which can be represented with a very high discount factor or low β, then this will make him more likely to not pool, since future rents are heavily discounted.

These dynamics have been uncovered assuming that π_2, or the proportion of honest types in the pool, is exogenously determined. This means we are not allowing for citizens to enter into politics driven by incentives. In the following section, I relax this assumption to allow for endogenous entry.

3.2 Endogenous Entry

In this section I extend the game to allow for the possibility of citizens to select into politics. Citizens, looking at their benefits from holding office vs remaining outside of politics make the decision of entering into public life, which in turn changes the pool of candidates from which voters can pick a challenger.

In the previous section, the decision of politicians to pool or not depends on their expected probability of reelection, which in turn depends on voters' decisions to reelect the incumbent or not. Voters will choose to reelect an incumbent when they perceive that the probability that the incumbent is honest, γ, is larger than their expected probability of choosing an honest politician from the pool of candidates, π_2. In this section, I allow for endogenous entry into politics, so that π_2 is endogenously determined by the choice of citizens to enter politics or not.

In order to construct solutions for the endogenous determination of π_2, we assume that society is composed of n people. A proportion α of these people are honest, while $1-\alpha$ denotes the proportion of dishonest citizens. Citizens decide whether to enter politics or seek employment in the

private sector, where outside wages are determined by a uniform distribution: $w^i \sim U[0, W^i]$, where $W^g \lesseqgtr W^b$. The pool of candidates for a given place is thus determined by the number of honest and the number of dishonest citizens that wish to enter politics. If voters choose not to reelect an incumbent, they elect a candidate from the pool. The challenger that wins is a random draw from the pool of politicians[1].

At the beginning of period 2, dishonest citizens will enter politics if $x_2 + E(\Omega_2) + R_2 \geq \bar{w}$, while honest politicians will enter politics if $R_2 \geq \bar{w}$, where $\bar{w}$ denotes the threshold level. This means that a fraction $\eta^g = \frac{R_2}{W^g}$ of honest citizens will enter politics, while a fraction $\eta^b = \frac{x_2+E(\Omega_2)+R_2}{W^b}$ of dishonest citizens will enter politics. Given these rates of entry, the pool of candidates will be composed of $\frac{R_2}{W^g}\alpha n$ honest challengers and $\frac{x_2+E(\Omega_2)+R_2}{W^b}(1-\alpha)n$ dishonest challengers.

Thus, the endogenously determined probability of selecting an honest candidate from the pool of candidates is now:

$$\pi_2 = \frac{\frac{R_2}{W^g}\alpha}{\frac{R_2}{W^g}\alpha + \frac{x_2+E(\Omega_2)+R_2}{W^b}(1-\alpha)} \tag{3.4}$$

This can also be written as $\pi_2 = \frac{1}{1+\Delta}$ where

$$\Delta = \frac{x_2 + E(\Omega_2) + R_2}{R_2}\frac{W^g}{W^b}\frac{1-\alpha}{\alpha} \tag{3.5}$$

The main impact of π_2 on the equilibrium behavior of politicians and voters comes from the comparison voters make between γ and π_2, when choosing whether to reelect the incumbent politician. This, in turn, affects a politician's behavior by creating incentives for him to pool or not pool with an honest type, which changes his probability of being reelected.

We have that

$$Pr(g|G = G(H)) = \frac{\pi_1 q}{\pi_1 q + (1-\pi_1)(1-q)\lambda} = \gamma \tag{3.6}$$

Voters will reelect incumbent with a positive probability (σ) only when $\gamma > \pi_2$. How does

[1]This is a simplification based on Besley (2004). Like Besley, I do not allow for challengers to signal their type or make investments to modify their chances of winning. These are possible extensions of the model.

Table 3.2: Equilibrium Conditions: With Endogenous Entry

Equilibrium Type	Behavior	Conditions: Exists iff
Pooling Equilibrium	$\lambda = \sigma = 1$	$q \geq \frac{(1-\pi_1)\pi_2}{\pi_1 - 2\pi_1\pi_2 + \pi_2}$ & $s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) \geq x_1 + \Omega_1 + R_1$
Separating Equilibrium	$\lambda = 0; \sigma = 1$	$s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) \leq x_1 + \Omega_1 + R_1$

the relationship between γ and π_2 change with endogenous entry? We can see that $\frac{\partial\gamma}{\partial\pi_1} > 0$, which means that for higher values of π_1, voters can expect with a higher probability that the politician is an honest type when they observe $G(H)$. This derives from the fact that a higher π_1 means that there was a higher ex ante probability that the politician was honest. However, for now π_1 is held constant, since we are not solving for endogenous entry in the first period.

We are interested in the comparison of γ and π_2, where π_2 is determined by a series of factors. Our main variable of interest is $E(\Omega_2)$. We can see that $\frac{\partial\pi_2}{\partial E(\Omega_2)} < 0$, meaning that when the expected future price of oil is high, more dishonest citizens are running for office, causing a deterioration of the candidate pool. Thus, when the expected future price of oil is high, the expected quality of challengers is lower and voters will tend to observe that $\gamma > \pi_2$, and reelect the incumbent. The opposite is also true, when the expected price of oil is low, voters expect the pool of candidates to be better because dishonest candidates have less incentives to run for office, and thus voters are more likely to observe $\gamma < \pi_2$, and choose to vote out the incumbent, electing a challenger from the candidate pool.

Given this equilibrium behavior, we can derive the following propositions:

Proposition 1: The pooling equilibrium will occur only if (1)$q \geq \frac{(1-\pi_1)\pi_2}{\pi_1 - 2\pi_1\pi_2 + \pi_2}$ and (2) $s_b^{L_p} + \beta\sigma(x_2 + E(\Omega_2) + R_2) \geq x_1 + \Omega_1 + R_1$.

(1) is the necessary condition for voters to reelect the incumbent given that they observe G^H, while (2) is the incentive compatibility condition that ensures that it is worthwhile for the incumbent to pretend to be a good type in period one so that he can be reelected and steal more in period 2.

Proposition 2: The effect of oil can influence the equilibrium via two channels: through its effect on π_2 in (1) and through its effect on the incentive compatibility restriction, (2). The higher the expected oil rents, the higher the likelihood that (1) is satisfied, and the higher the likelihood

that (2) is satisfied. Thus, pooling becomes more likely when expected oil rents are high.

3.3 Predictions of the Model and Comparative Statics

Taken together, the effects of windfalls on the different actors interrelated decisions lead to certain predictions about the effects of windfalls on corruption rates, reelection rates and the honesty of candidates that run for office in oil affected places. The results of the model suggest that we can make the following predictions derived from the model's different parameters:

Prediction 1: Rents (s_1) are an increasing function of oil revenue today Ω_1. This prediction represents the effect that windfalls have on average corruption levels. Places affected by windfalls should this experience higher corruption rates than those not affected by windfalls.

Prediction 2: Rents (s_1) are a decreasing function of oil revenue tomorrow $E(\Omega_2)$ compared to oil revenue today Ω_1. This is driven by corrupt first term mayors pooling in an attempt to get reelected. This prediction stems from the dynamic effects generated by the price cycle of oil windfalls. If oil windfalls are expected to be very large in the following period, as they are during booms, then dishonest incumbents have an incentive to pool with honest incumbents, stealing less in the current period in an attempt to gain reelection and access future rents.

Prediction 3: Reelection is more likely when the initial pool of candidates , π_1, is high. If π_1 is high, this means that the ex ante likelihood of an incumbent being honest is high. Under these circumstances, the bayesian updating which takes place has to lead to a significantly lower likelihood that the incumbent is dishonest, and the deterioration in the pool of candidates has to be sufficiently significant for the voters to decide that it is worthwhile to replace an incumbent with a randomly selected member of the pool of candidates.

Prediction 4: Reelection is more likely when the honesty of the incoming pool of candidates is low, which happens when $E(\Omega_2)$ is high, since $(\frac{\partial \pi_2}{\partial E(\Omega_2)}) < 0$. This prediction stems from the fact that when $E(\Omega_2)$ is high, more dishonest types enter into politics in an attempt to access rents in the future. This leads to the deterioration of the pool of candidates, π_2. Voters will reelect based on

the comparison between their updated beliefs about the honesty of the incumbent and the expected honesty of the selected candidate from the pool. When the former is higher than the latter, the incumbent will be reelected. Thus, when the honesty of the pool of candidates is very low, the likelihood of reelection is higher.

Prediction 5: More corrupt types will be reelected when $E(\Omega_2)$ is high compared to Ω_1. This prediction stems from the fact that dishonest types will steal a little less in their first term in an effort to pool and get reelected. Thus, when $E(\Omega_2)$ is high compared to Ω_1 (boom period), more dishonest types pool, and more get reelected.

Prediction 6: The number of candidates entering a race should be higher when $E(\Omega_2)$ is high compared to Ω_1. This stems from the fact that when $E(\Omega_2)$ is high, more citizens will decide to enter into politics, lured by the promise of accessing high rents in the future period.

Prediction 7: The quality (honesty) of the pool of candidates should be lower when $E(\Omega_2)$ is high compared to Ω_1. Prediction 6 is mainly driven by this dynamic, most of the increase in total candidates running for office is driven by the entry of dishonest candidates who care about accessing rents in future periods.

For the purposes of the dissertation, I consider elections that happen when $\Omega_1 < E(\Omega_2)$ as elections during booms, and elections where $\Omega_1 > E(\Omega_2)$ as elections during busts. Table 4.4 in the Chapter 4 shows what this looks like when taken to the actual data. Table 3.3 shows the comparative statics derived from the model for royalty receiving municipalities. The comparative statics imply certain effects during elections, such as reelection rates, number of candidates running for office and the quality of the pool of candidates, as well as effects for the period after elections, such as the number of corrupt incumbents that are reelected (due to pooling) and the levels of corruption.

To sum things up, for elections held during boom periods in windfall affected municipalities, we expect a higher reelection rate, more candidates winning reelection and more corrupt incumbents winning reelection, compared to non windfall affected municipalities. Additionally, we expect to see a larger number of candidates running for office, and a deterioration in the average honesty of the candidates in the pool. These electoral dynamics will then lead to a higher proportion of

Table 3.3: Comparative Statics for Royalty Receiving Municipalities: Booms versus Busts

	Elections during Booms $\Omega_1 < E(\Omega_2)$	**Elections during Busts** $\Omega_1 > E(\Omega_2)$
Prob. Reelection	+	-
Candidates Reelected	+	-
Corrupt Candidates Reelected	+	-
Number of Candidates	+	-
Honesty of Pool of Candidates	-	+
	Term After Boom Election	**Term After Bust Election**
Prop. Corrupt Incumbents	+	-
Corruption	+	-

incumbents in office being corrupt and higher levels of corruption for the term after a boom election.

For elections held during a bust, we see the opposite results. We expect less incumbents getting reelected, which also means fewer dishonest incumbent will gain reelection. The number of candidates will be smaller and the average honesty in the pool will improve. For the term after a bust election, we expect fewer corrupt politicians to hold elected office and lower levels of corruption.

3.4 Empirical Implications of the Model

In the Brazilian context under study, the model allows us to derive several different hypotheses, which can then be tested on the data. In particular, we can derive hypotheses about rates of corruption, reelection and entry into politics. The hypotheses presented below represent some of the testable implications I derive from the model and will test on data in the following chapters.

H1: *Corruption will be higher in royalty receiving municipalities.* This hypothesis is mainly driven by the moral hazard effect of the shocks. Large inflows of money into government coffers generate more opportunity to embezzle at a lower cost to voters. Candidates with access to more money will steal more. If we take this as the average b

H1.b: *Corruption will be higher for second term mayors.* This is driven by the fact that second term mayors have no incentive to pretend to be good types because they cannot get reelected.

H1.c: *Corruption will be high after a boom election and lower after a bust election* This is

driven by the selection effect. Corrupt mayors pool more during booms and so are reelected more often during booms, leading to higher corruption in the term after a boom election.

H2*: Reelection rates will be high when the expected price of oil is high, resulting in a higher number of corrupt types getting reelected and high levels of corruption in their second term.* This is driven by two effects. First, the fact that corrupt types will pool with honest types with a higher probability when the expected inflows from oil are higher in the next period. Second, the fact that more corrupt types will enter politics when expected royalties are expected to be high, leading voters to reelect incumbents more often.

H2.b*: Reelection rates will be lower when the expected price of oil is lower than the current price of oil.* When the level of royalties is high and the expected future income from royalties is low, corrupt incumbents will steal as much as possible and likely not get reelected.

H3*: The pool of candidates will contain more corrupt types when future royalties from oil are expected to be high.* This hypothesis stems from the fact that corrupt types will perceive that there are more embezzlement opportunities in these municipalities, making politics relatively more attractive compared to the outside market.

The formal model presented in this chapter allows us to mathematically identify some possible mechanisms through which oil windfalls affect local politics in Brazil. It allows us to track what would change if we changed certain parameters by analyzing the comparative statics derived from the equations and derive testable hypotheses. In the following chapter, I will outline the measurement strategies and data which I will use in order to test these hypotheses. I will then test them data from Brazilian municipalities between 2000 and 2016.

4 Context, Measurement and Data

The Brazilian case provides an ideal setting to test the hypotheses derived from the theory presented in the previous chapter. In the past decades, Brazil became an important oil producing country, making it an exemplary place to test the implications of the theory. Additionally, almost all previous research on the relationship between natural resource rents and political corruption is based on observational evidence and thus beset with identification problems. Oil production is potentially endogenous to the honesty of elected officials. In addition, oil windfalls determine embezzlement opportunities, affecting both the choice of citizens to run for office and the performance of those who are elected. Brazil provides us with an optimal setting to test the theory at the micro-level, given the existence of exogenously determined oil royalties at the municipal level, as well as unbiased corruption measures for a representative sample of municipalities.

4.1 The Brazilian Context

Before I go into the measurement of the main dependent and independent variable, I will provide some background on the Brazilian context, first on the institutional context and municipal governments in Brazil, which are our unit of observation, and the on the oil industry in Brazil, which is the source of the windfalls I study in this dissertation. It is important to note that while the theoretical implications of the model should travel well to many different contextual settings, Brazil provides an exemplary setting on which to test the hypotheses derived by the model.

4.1.1 Municipal Governments in Brazil

Brazil is a federal presidential constitutional republic. The federation is composed of 26 states and 1 federal district, and within these, municipalities. Brazil is considered one of the most decentralized federal systems in the world, with local governments carrying a large responsibility in government service provision. Municipalities are the main entities responsible for providing education, primary health care and other public services such as local infrastructure, transportation and in some cases a local police force. Each municipality is governed by a mayor (prefeito) which is elected every four years and can serve two consecutive terms in office. The elections analyzed in this study are those held in 2000, 2004, 2008 and 2012. In small and medium sized municipalities, the mayoral elections are majoritarian, first-pass-the-post. In large municipalities, those with 200,000 or more inhabitants, if no candidate reaches more than 50% of the vote-share, a run-off election is called and the two most voted candidates go on to dispute the election in a second round of voting. Municipalities also have a legislative body, the municipal council (Câmara de Vereadores), which is also elected every four years, concurrently with the mayoral elections, by proportional representation. Municipal councils vary in size from 9 to 55 members, depending on the size of the city, where more populous cities are generally allocated larger municipal councils. There are 5,570 municipalities in Brazil, which include Brasilia, the capital and federal district, and the state district of Fernando de Noronha.

Municipal budgets are funded by a combination of transfers from the federal level, the state level and local taxes on on property and economic services. However, local taxes actually comprise a small percentage of the total municipal budget. This means municipalities are highly reliant on transfers from the federal and state government to fund their expenditures. The main municipal level taxes are a property tax on urban real estate (Imposto Sobre Propriedade Predial e Territorial Urbana, IPTU), a tax on services (Imposto Sobre Serviços, ISS), and a tax on the transfer of real estate (Imposto Sobre a Transmissão de Bens Imóveis, ITBI) [1]. These taxes are determined at the local level by the mayor and the city council. Although municipal taxes are a small percentage of the total

[1] See cite Souza 2004 for more detailed information on these taxes

tax base, municipal expenditure represents a larger proportion of government expenditure in Brazil. For example, in 2005, municipal taxes represented 5.8% of total taxes in Brazil, while municipal expenditure represented 17.3% of total government spending (Brambor 2016). Municipalities have high levels of discretion over how they spend their budgets, and decisions are mainly made by mayors in conjunction with the municipal council.

4.1.2 The Oil Sector in Brazil

While as a federation Brazil is highly decentralized, the oil sector is highly centralized. The Brazilian Union owns the oil under Brazilian land and the federal government has the responsibility of extraction, production, transportation and commercialization of the resource through Petrobras, the national oil company. Up to 1997, the oil sector was mainly regulated by the 1934 Constitution and the Mineral Code (Código de Minas) which was passed the same year as the Constitution. These legal bodies established a nationalization of the mining industry and its resources. In 1938, this same legal structure which existed for other minerals was extended to oil and natural gas. Law No. 366/1938 added specific regulations for the oil and natural gas sectors to the 1934 Mineral Code, so that from 1938 onwards oil belonged to the Union and the States, and could no longer be considered private property. Law No. 395/1938 declared the oil sector and oil supply a strategic sector with national security implications, making the Union the only actor legally competent to act in the sector through the National Council for Petroleum (CNP - Conselho Nacional de Petróleo).

Petrobras was created in 1953 and was the product of a broad, nationalist-inspired public movement (Trojbicz 2019) known as the "Campaign for Oil" (Campanha do Petróleo) which had the campaign slogan "The oil is ours" (O petróleo é nosso). This campaign grew as a force of opposition to a market liberalizing project known as the "Oil Statute" (Estatuto do Petróleo) (Trojbicz 2019). During the military governments (1964-1985), a centralization and concentration of revenues from oil was undertaken, in an effort to accumulate wealth and power at the center. After the concentration of oil revenues in the federal government promoted by the military government, oil revenues began to be distributed to states and municipalities again in 1985, through Law No.

7,453/1985. This law mainly benefited producing states and municipalities and was based on a mostly onshore oil production matrix. The economic rationale behind this was that these producing states and municipalities should be compensated for the negative effects of oil production on their lands, and also for changes in the ICMS (value added tax) which was charged at place of destination, which would benefit consumers, as opposed to the place of origin which would benefit producers. This geographic distribution rule which is still used to date was largely based the assumption that future discoveries of oil would also be onshore, a fact that was proven wrong in the years to come.

In 1988, Brazil approved a new constitution under democratic government. Though the 1988 constitution made some changes to the oil sector, especially with regards to the distribution of revenues from oil, it maintained the federal ownership of oil resources as well as the monopoly of oil exploration by Petrobras. It was only in 1997 during Fernando Henrique Cardoso's government, when the Oil Law was passed (Law No. 9,478/1997), that the constitutionally guaranteed monopoly that Petrobras enjoyed in the oil exploration sector in Brazil legally ended[2]. This reform took place in a context of privatizations and market liberalization policies, where the issue of the monopoly over oil was center stage. Although Petrobras was never privatized, throughout this liberalization period the company went through a serious reform. The government reduced its participation in the total shares of the company from 82% to 51%, a process known as a partial privatization (Bercovici 2011). While the government incorporated more private shareholders, it maintained the majority share position and thus retained its power over final decision making. In 2001, shares of Petrobras began being traded in the New York Stock Exchange, allowing the company to attract cheaper financing options, and also submitting it to the supposedly more stringent transparency requirements established by the Securities and Exchange Commission (SEC) of the United States of America.

The Oil Law also created the National Petroleum Agency (Agéncia Nacional do Petróleo - ANP) to regulate the market. This highly technical and professional agency was in charge not only of regulating the oil sector but also of calculating the amounts of royalties owed by each oil firm to the Brazilian government, as well as promoting research to delimit new exploration blocks and

[2]It is important to point out that the government has kept provisions and rules that still allow Petrobras to have an outsized share of the market

oversee new contracts. Many of the attributions which used to be concentrated in Petrobras, like the conduction of geological studies, were know handed to ANP. This looked to put Petrobras as an equal player in the new, competitive industry and thus attract investment from other international oil companies.

As is discussed further in the section below, the Oil Law also increased the royalties from 5% to 10%. Oil production grew exponentially as a result of the 1997 reform, going from 2.8% of Brazil's GDP in 1997 to 10.5% in 2005 (Trojbicz 2019). Following the increased production, government revenues from royalties grew 20 fold between 1998 and 2010, representing an enormous windfall which was also highly concentrated. For example, in 2010, the state of Rio de Janeiro received 82.5% of the revenues which were destined to the 27 states of the Union (Trojbicz 2019).

In 2007, the discovery of enormous oil deposits off the coast of Brazil, known as "pre-salt" due to their ultra-deep water location, finished establishing Brazil as an important oil producer in the international stage. Following the discovery, Lula announced that "God is Brazilian!". The discovery of the "pre-salt" fields doubled Brazil's known oil and gas reserves, and only two years later, Petrobras became the fifth largest company in the world, cementing Brazil as an important player in the oil industry. The economic boom, mostly fueled by the commodity boom, led to The Economist publishing a famous article, "Brazil takes off", featuring an image of the famous Christ taking off like a rocket ship[3]. It seemed that God was, in fact, smiling upon Brazil.

Throughout many decades and up to the explosion of "Operação Lava-Jato" (Car Wash Operation[4]), Petrobras enjoyed high credibility and was the subject of international praise for being one of the best performing and most transparent National Oil Companies (NOC). Petrobras is unique in its governance structure, a feature many believed helped it reign in common temptations experienced by other NOCs. Petrobras' hybrid public-private ownership structure, where the Brazilian government owns 51% of the shares while the rest are publicly traded in the Brazilian and US stock-exchange made it a case study in innovation and alternative governance structures. In 2013, just before the Car Wash investigation became public, the Natural Resource Governance

[3]https://www.economist.com/leaders/2009/11/12/brazil-takes-off

[4]For more on corruption within Petrobras and the Car Wash Operation, see Paduan (2016); Gillies (2020)

Institute (NRGI) awarded Petrobras a score of 92 out of 100 for its transparency and governance practices (Revenue Watch Institution 2013; Gillies 2020).

Although the Car Wash Operation is a prime example of how oil can lead to corruption inside National Oil Companies, within the contracts related to oil extraction and at the federal level of government (which has control over the NOC), this dissertation focuses on a different but related phenomenon: the effect of windfalls into local government coffers on accountability and corruption at the local level of government. Importantly, the corruption I study has no direct relation to the corruption that goes on in contracts for oil exploration. In fact, in the cases I study oil only affects these municipalities through the royalties that enter into the municipal budget. This means that this theory can apply to resource dependent places that don't have NOCs, and is mainly driven by the large fluctuations in the size of government budgets.

4.2 Measuring Windfalls

Research on the resource curse has grappled with the measurement question for decades. Oil production is potentially endogenous to the honesty of elected officials, as well as to other characteristics of the local environment. In addition, oil windfalls determine embezzlement opportunities, affecting both the choice of citizens to run for office and the performance of those who are elected

To overcome identification concerns, I exploit a natural experiment where royalties in Brazil are allocated to municipalities based on an exogenous geographic rule and the international price of oil. In Brazil, oil royalties are distributed on a monthly basis to States and Municipalities as a way of compensating for the exploitation and production of petroleum and natural gas. These royalties began to be distributed when the state owned oil company, Petróleo Brasileiro SA (Petrobras) was created under Law No. 2004 of October 3, 1953. At this point, Brazil was not a large producer of oil, most of the reserves were onshore, and the expectation was that any future discoveries would likely be found in the North East of Brazil (Brambor 2016).

Initial royalty payments set by this law determined that 4% of production value would be

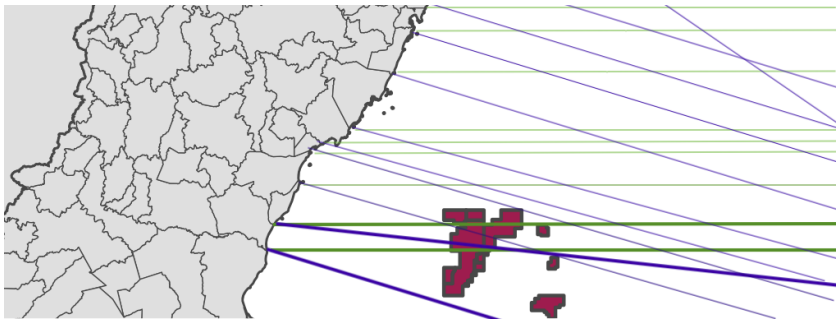


Figure 4.1: Geographic Rule for Royalty Assignment

distributed directly to state governments, while 1% of this value would be distributed to municipal governments where production occurred. Since at this time Brazil produced very small amounts of oil, these payments were almost negligible and the passing of this law was politically uncontroversial.

It was only after the important discovery of oil in the Campos Basin, off the coast of the state of Rio de Janeiro, that the law was extended to include and regulate offshore royalty payments. In Law No. 7453 of December 27, 1985, royalties were kept to an overall 5%, however the distribution changed. The new law established that 1.5% of production value would be distributed to states and 1.5% to municipalities which were determined to be "fronting" the coast where the production occurred. The rule of allocation was defined by projecting the borders of municipalities into the ocean, using both parallel to the latitude lines and orthogonal to the municipal borders, as shown in Figure 4.1. Municipalities can receive royalties if they are designated as principal producing municipalities, secondary producing municipalities (neighboring cities) and whether they are in any way affected by production of oil (for example, if a pipeline passes through the municipality). The law also established that remaining 2% out of the 5% of production value was to be divided equally between a special fund (Fundo Especial) which would benefit all states and municipalities in the country, and the Navy.

In 1997, the Petroleum Law (Law No. 9478 of August 6, 1997) was adopted. Apart from creating the National Petroleum Agency (Agência Nacional do Petróleo - ANP) which would take over regulation of the oil sector and the National Council for Energy Policy (Conselho Nacional de Política Energética - CNPE), this law changed the way royalties were calculated and distributed.

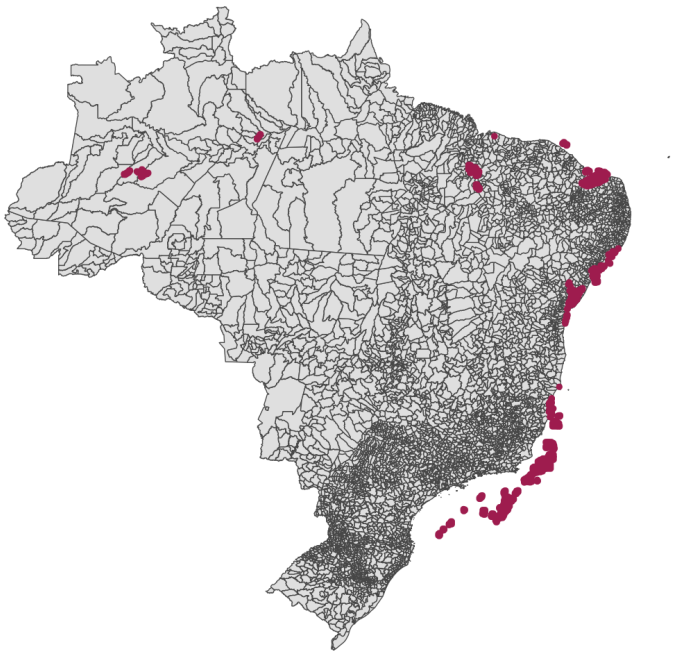


Figure 4.2: Geographic Distribution of Oil Royalties (includes offshore and onshore).

Table 4.1: Oil Royalties Distribution Defined by the Oil Law of 1997 (Trobjbicz 2019)

	Onshore up to 5%	**Offshore up to 5%**	**Onshore 5% - 10%**	**Offshore 5% - 10%**
Producing State	70%	30%	52.5%	22.5%
Producing/Neighboring Municipality	20%	30%	15%	22.5%
Municipality with oil plants	10%	10%	7.5%	7.5%
Ministry of Science and Technology			25%	25%
Ministry of the Navy		20%		15%
Ministry of Finance		10%		7.5%

The Petroleum Law of 1997 left the existing royalties distribution scheme for royalties of up to 5% of the value of crude oil and natural gas that started in 1989 in place (Law No. 7990 - 1989, Decree No.1 1991, see also Law No. 9478 - 1997, Art.48) (Brambor 2016). However, the new law raised additional revenue from royalties, determining that royalties exceeding five percent of the production value (between 5% and 10%) were to be distributed as follows: (i) for onshore production, 15% of royalties are assigned to municipalities where production occurs and 7.5% to municipalities affected by operations; (ii) for offshore oil production, 22.5% of royalties are assigned to municipalities fronting the production areas, and 7.5% to municipalities affected by operations.

For offshore production, a municipality is considered a producing municipality if it faces an oil well, according to the parallel and orthogonal lines defined in the 1985 law. Furthermore, these lines were not defined by political negotiations and were not subject to manipulation according to municipal interests since they were defined by the IBGE based on geodesic lines. At the time of the definition of these lines, Brazil was not considered a major player in the oil industry, oil prices were in significant decline, royalty amounts were very small, and most of the oil discoveries had not been materialized. Therefore, the municipalities benefiting today had no knowledge that they would eventually be receiving large amounts of cash from this law, and thus had no incentive to lobby for or against it. Offshore royalties are thus exogenously determined with respect to municipal characteristics, since municipalities have no capacity to determine where oil fields will be located,

and once these rules were set in 1985, they could not modify their geographic characteristics.

The final rule of allocation for municipalities thus depends on the "facing quota" (confrontação), determined by the parallel and orthogonal lines and the production value assigned to each oil well. If more than one municipality "faces" an oil well, then the distribution of royalties from that well between the municipalities will be determined by the "facing quota" and the population in each of the facing municipalities (municípios confrontantes). The production value is determined by the amount of oil produced in each well and the international price of oil determined by ANP on a monthly basis. Royalties are thus directly determined by the international price of oil, and follow its cycles very closely. The ANP is responsible for calculating the production values, facing quotas and population percentages, which ultimately determines the amount of royalties which are to be distributed to each level of government.

Figure 4.3 shows how the total amount of royalties received by municipalities correlated with the international price of oil. The amount of royalties grew steadily throughout this period, showing a significant fall after the 2008 crash in the price of oil, and another steep decline after 2014, also due to an important fall in the international price of oil. In the figure, the dashed vertical lines represent years in which a municipal election was held, which will be important for our tests in the following chapter.

In Brazil, offshore production represents more than 90% of total oil production. Furthermore, the infrastructure dedicated to provide support and services to this offshore production is concentrated in one city in Rio de Janeiro, Macaé (Ferraz and Monteiro 2014). This means that the oil industry jobs associated to refinery, technology and the entire industrial complex that surrounds oil are concentrated in one place. Most of the municipalities receiving royalties have no direct job production due to oil extraction. In fact, in an interview with a former employee of Petrobras and ANP, he mentioned: "*The royalties were meant to be reparations for environmental externalities but in most of these municipalities you would have to travel 8 hours by boat in order to reach the oil fields. The oil exploration does not directly affect their economies or their lives.*"[5] He also

[5]Interview with anonymous employee of Petrobras and ANP on September 14, 2018 in Rio de Janeiro, Brazil.

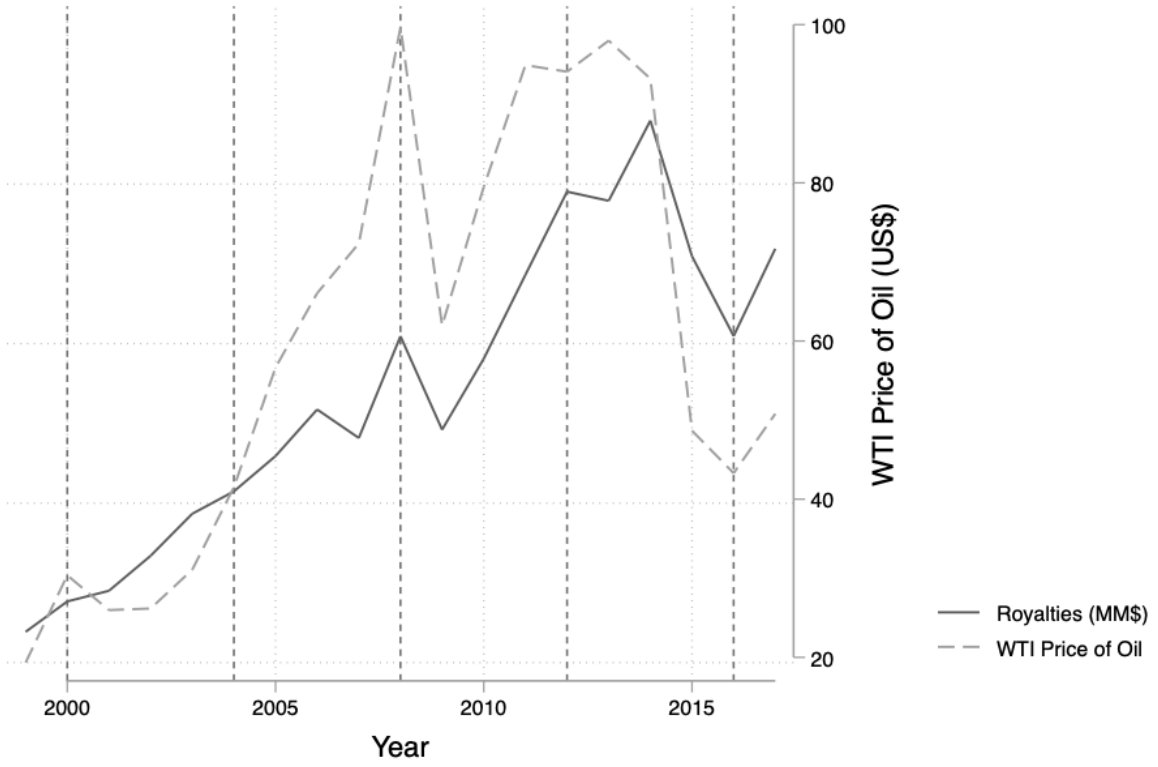


Figure 4.3: Royalties Distributed to Municipalities and International Price of Oil

emphasized: "ANP is a totally independent and highly technical agency and municipalities have little sway on the calculations conducted inside the agency.... Similarly, Petrobras' decisions on where to drill are highly technical and usually decided in conjunction with other international oil companies. It is very unlikely that a mayor of one of these municipalities can have an effect on the rules determined for distribution of royalties or the amount of oil pumped off their shores." The timing of the rules as well as the way in which they are applied provides us with sound evidence that local municipal governments have no political influence on the amount of royalties they receive. Figure 4.2 shows that most of the royalties are concentrated in coastal states, with the exception of a large source of onshore royalties located in the Amazon.

Municipalities in Brazil are the main receivers of royalties, receiving between 24% and 34% of total royalty payments distributed by the Federal Government, depending on the year we analyze. All this has resulted in royalty receiving municipalities experiencing a strong external shock to their

finances which fluctuates with the international price of oil. The change in the law in 1997 together with the rise of the price of oil meant a large increase in external transfers to municipalities. The drop in the price of oil in 2008-2009 together with the political and management crisis in Petrobras has only made oil royalties more volatile and unpredictable. Brazilian municipalities thus provide a uniquely suitable setting for testing the theory presented above.

4.3 Measuring Corruption

The measurement of corruption has been a challenge for academic work on the topic. Corruption is an act which is illicit by its very nature. As such, if done correctly, it should not be observed. This makes measuring corruption a very difficult task. A "clever" corrupt politician will try to limit the trail of evidence attached to his corrupt acts. Bribes are usually a cash business, and politicians are very resourceful in the ways they account for missing funds, hide illegal procurement processes and hide paper trails to their malfeasance. Additionally, the focus on local governments means that decentralized oversight is sometimes difficult, and national level controlling agencies don't always have the capacity or resources to properly monitor and audit them. To overcome the difficulty of observing and measuring political corruption, I use data on corruption obtained from random audits conducted by the Brazilian federal government. Most of the previous literature on corruption relies on cross-national measures of corruption, which suffer from important data limitations.

Different types of corruption measures have been used in the literature. The first type are broad, corruption perceptions indices which are usually derived from expert opinions or surveys that try to get at people's perceptions of the extent of corruption in the places they live. A second type is experiential measures, where people are asked directly whether they (or someone they know) have engaged in corruption or the payment of bribes. Finally, there are some novel measures of corruption done from randomized audits, experiments and indirect measures (Olken 2007) which are usually micro-level, within country measures.

The widely used Transparency International's Corruption Perceptions Index and the Political Risk Survey Corruption Index are ultimately measures of perceived corruption by elites (Treisman 2007), and fall squarely in the first type of corruption measure. It is not clear how well actual levels of corruption map onto corruption perceptions, since it is likely that such perceptions are muddled by other factors such as overall economic strength and lack of bureaucratic hurdles (Treisman 2007). These factors may in turn correlate with the outcomes of interest, making the estimated effects unreliable. In a revealing study, Razafindrakoto and Roubaud (2010) find that experts systematically over estimate the proportion of families that have been forced to pay a bribe in West African countries. Not only do their perceptions differ significantly in magnitude from the experiential measures reported by families, but importantly, they do not manage to correctly rank countries in order of most corrupt to least corrupt. There may also be important shortcomings from experiential measures. People may not be willing to report engaging in corruption given that it is an illegal act and that they may not want to reveal this type of behavior to the surveyor (this is known in the literature as Social Desirability Bias).

The use of micro-level measures of observed corruption solves many problems associated with corruption perceptions indexes used in previous literature, since the measure reveals actual corruption levels. Moving in this direction, other types of work have used data from auditing agencies. Although audit date is better at getting at actual corruption rather than perceived corruption, it can suffer from important selection bias: auditing agencies usually expend their limited resources auditing places where there has been a whistleblower, complaint or where there are expectations that acts of malfeasance are taking place. This means that places where there is no expectation of corruption taking place do not get audited at the same rate as places where we do expect corruption to be taking place. This will inevitably lead us to have biased samples, where corrupt places are overrepresented in the data.

The random audits data available in Brazil helps us take care of both of these concerns: they get at actual corruption rates for a randomly selected, representative sample of municipalities. Thanks to an innovative policy experiment, Brazil has some of the best micro-level data on actual

corruption levels available for research. In 2003 the auditing agency (CGU- Controladoria-Geral da União) began randomly selecting 50 municipalities to be audited. The number has now risen to 70 randomly selected municipalities and the eligibility criteria has changed slightly over time, with the threshold rising to 500,000 inhabitants. Due to the population cut-off, this process excludes about 8 percent of Brazil's approximately 5,500 municipalities. Excluded cities comprise mostly the state capitals and large coastal cities which are more heavily populated.

In this dissertation, I use data from the random audits described above to construct a dataset that contains corruption measures between 2000 and 2017. My measure is most similar to Brollo et al. (2013), who create a corruption variable which identifies the fraction of audited funds which were involved in corrupt acts.[6] The randomization of the audits eliminates any bias in the measure of corruption which could result from selection of municipalities into the auditing process. Common concerns with measures of corruption through audits that are not randomly assigned include issues like: (i) municipalities that are more corrupt are more likely to be audited, which leads to overestimation of corruption; (ii) politically connected municipalities are less likely to be audited; and (iii) if politically connected municipalities are also more corrupt, then corruption would be underestimated. Given the random assignment to audits, the data used for this dissertation is largely free of these issues.

The types of corrupt acts covered by the dataset include fraud in procurement activities, missing funds or diversion of funds, over-invoicing and other inconsistencies in the municipalities' finances such as fake receipts, invoicing to fake firms, etc.

The data on corruption is thus a pooled cross section of random audits, municipalities enter the dataset as they are selected to be audited. The data provides a representative sample of municipalities, making it possible to make comparisons without having typical problems of pooled cross sections that are not randomly selected. However, the probability of a municipality being selected for audit more than once during this period is quite low. The data is available for 4 terms (2001, 2005, 2009 and 2013) from 40 lotteries between 2001 and 2017.

[6]Results are robust to using only Brollo et al. (2013) data or only the Ferraz and Finan data in Avis et al. (2018) data, however my data provides a longer timeline which helps capture the dynamic effects of oil.

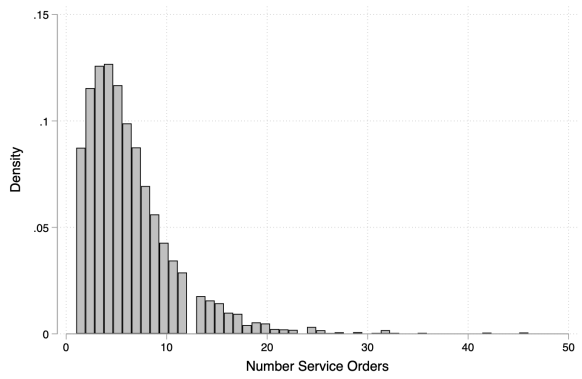


Figure 4.4: Service Orders Per Municipality-Year

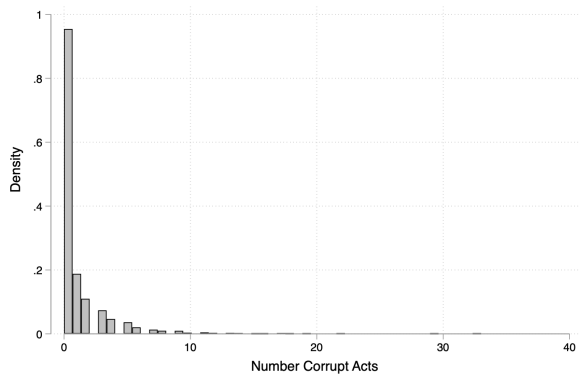


Figure 4.5: Corrupt Instances per Municipality-Year

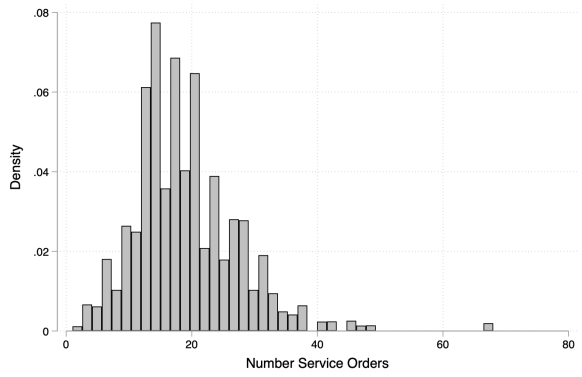


Figure 4.6: Service Orders Per Municipality-Term

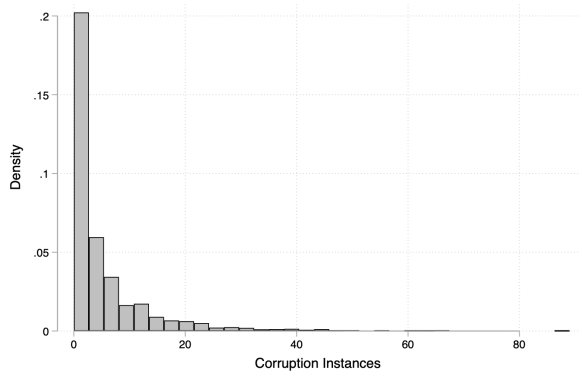


Figure 4.7: Corrupt Instances per Municipality-Term

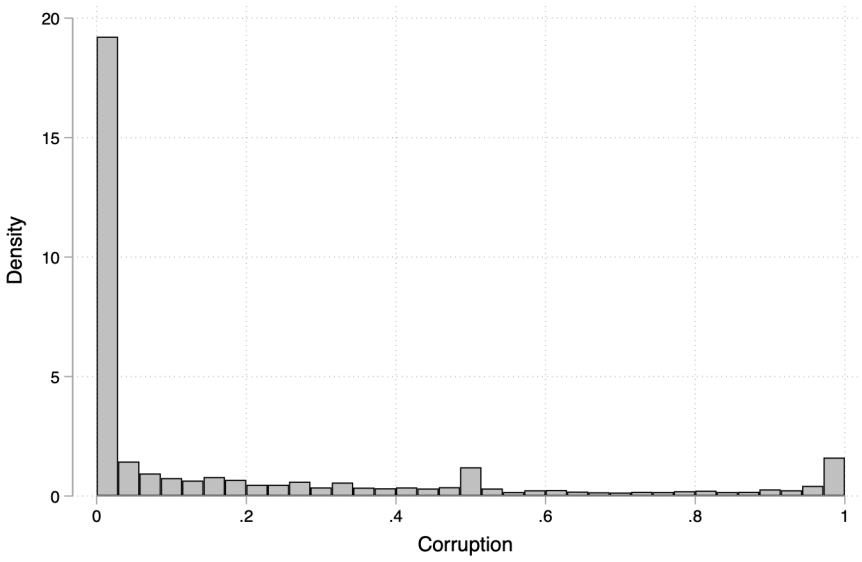


Figure 4.8: Fraction of Audited Funds Identified as Corruption

When a municipality is selected to be audited, CGU issues a number of service orders to determine which funds it will audit. On average, CGU issues 6.4 service orders per Municipality-Year, which means that in a four year term, there will be about 26 service orders per municipality. For audits after 2006, CGU has created a spreadsheet where they detail every issue identified in each service order for each audit[7]. The spreadsheet is based off of the in depth reports which CGU prepares where it describes in great detail and provides evidence of the issues it identifies. In the spreadsheet, each instance within each service order is classified as a "Falha Grave", serious offenses, or "Falha Média", medium offenses. For later years, the classification of "Falha Administrativa" also begins to appear in the data. Upon careful study of these instances, I decide to group instances of "Falha Administrativa" in my data with "Falha Media" instances, since these correspond to bureaucratic errors which cannot be considered pre-meditated malfeasance. This is in order to maintain time consistency in the definitions, since this new category corresponds to a new coding regime by CGU. Serious offenses are generally acts of blatant corruption such as the detection of fraud in procurement activities, diversion of funds, over-invoicing and other inconsistencies in the municipalities' finances such as face receipts and invoicing fake firms. Medium offenses usually imply some form of mismanagement where relevant information is missing, workers miss important deadlines, etc.

I consider only serious offenses ("Falha Grave") as instances of corruption, since most of the medium offenses appear to be bureaucratic errors that are either due to incompetence or human error, but would not qualify as a pre-meditated act of corruption. Thus, under my classification, only serious offenses qualify as corruption. The spreadsheet identifies the year in which the offense took place. It is important to note that many of the offenses uncovered happened in years prior to the year of the audit. In some instances, the offenses identified took place during the electoral period prior to the period in which the audit is being conducted. Given that what we care about when we study corruption in the context of this thesis is the year in which the corruption happened, rather than the year in which it was discovered, my coding scheme will attribute the corruption to the

[7]This is the same spreadsheet used in Avis et al. (2018), although the way in which they code the information is different, as explained below

year/period in which it took place. This is one important way in which my coding follows Brollo et al. (2013) and deviates from Ferraz and Finan (2008) and Avis et al. (2018). This choice makes sense in this context given that what we are interested in is identifying the corruption when it takes place rather than identifying when it is discovered (or the effect of this discovery), in a similar vein to Brollo et al. (2013). For work which looks to identify the effects of the audits and the release of their information, the approach by Ferraz and Finan (2008) and Avis et al. (2018) is better suited.

When an instance is classified as a serious offense, I consider the amount of funds identified in that instance as funds used in corruption. Thus, for each municipality, I first identify the number of corrupt instances identified in each year. I then identify the amount of funds found to be used in corruption each year, which correspond to the funds from the instances identified in the previous step. I then add the corrupt funds for all years within a term and divide by the total amount of audited funds that term. This is the main corruption variable which will be used throughout, and represents the proportion of audited funds that were engaged in corruption.

For audits which happen before 2006, the process is less straightforward given that we do not have the spreadsheet produced by CGU. Here, I use Brollo's data and the audits included in the spreadsheet as a guide. For audits that are included in both datasets so there is overlap, I go back to the PDF reports produced by CGU for the audits before 2006. I identify the instances that can be classified as serious offenses using keyword searches and reading through the summary description of each instance at the beginning of the reporting for each instance. Keywords include "fraud", "collusion", "fake", "procurement simulation", "ghost firms", "goods non located", "firm not located", "non-existing firm", "ghost firm", "overpricing", "lack of expenditure proof", "procurement process manipulation", "paralyzed construction", "non-existing object", "stolen", "charged and unrealized", "payment for unrealized works", "diversion of goods/assets" among others.

The PDFs contain a table with all the audited fund and the different audited agencies within the municipality that looks like Figures 4.9 and 4.10. This is based on an audit conducted in 2004 in the municipality Tabocas do Brejo Velho in the coastal state of Bahia. As Figures 4.9-4.10show, the total amount of funds audited in this municipality was BR$3,095,226.00 with a total of 29 service

Table 4.2: Example Audit Spreadsheet Reconstruction: One Instance in Audit No. 056

Ano evento	Audit Year	2004
Municipio	Municipality	Tabocas do Brejo Velho
Cod Mun	Municipality Code	32979
Uf	State	BA
Nr OS	Number Instances	29
Montante Fiscalizado	Amount Audited	BR$3.095.226,00
Montante Corrupto	Amount Corrupt	BR$20,424.00
Exercisio Repasse	Year of Offense	2003
Tipo Constatacao	Type of Offense	Serious Offense
Descricao	Description	Diversion of assets acquired with government resources
Entidade	Entity	Ministério do Desenvolvimento Social e Combate à Fome

orders. Figures 4.11-4.12 show the instances identified in the audit, with a short description of each instance. Table 4.2 shows an example of a serious offense involving the diversion of assets acquired with government funds. Here, the amount involved was of BR$20,424.00 which were used to "purchase" children's games which were actually not acquired and not present in the municipality. In this sense, the auditors conclude that the funds that were supposedly used to purchase these games were actually diverted by the government. This is one example of a serious offense which happened in 2003. Following this method, I am able to reconstruct the CGU spreadsheet created audits post 2006, for audits between 2003 and 2006.

4.1 **Recursos recebidos e quantidade de fiscalizações realizadas**

Ministério Supervisor	Programa/Ação Fiscalizado	Quantidade de Fiscalizações	Recursos Aplicados
Ministério do Desenvolvimento Agrário	Financiamento e Equalização de Juros para a Agricultura Familiar – (Pronaf)	4	189.186,00
	Assistência Financeira a Projetos de Infra-Estrutura e Serviços Municipais	2	151.600,00
Ministério da Educação	Bolsa-Escola	1	272.610,00
	FUNDEF	1	1.469.187,00
	Alimentação Escolar – PNAE	1	101.530,00
	Expansão e Melhoria da Rede Escolar Estadual de Ensino Médio	3	

Figure 4.9: Table Listing Audited Funds

Under this coding scheme, there is an average of 1.15 corrupt acts per municipality-year and 6.64 corrupt acts per municipality-term. Figures 4.4- 4.7 show the distribution of service orders and corrupt acts identified per municipality-year and municipality-term. Thus, the fraction of audited funds that were involved in corruption can be seen in Figure 4.8. The average percentage of funds

Ministério Supervisor	Programa / Ação	Quantidade de Fiscalizações	Recursos Aplicados
Ministério da Previdência Social	Pagamento de Aposentadorias	2	-
	Fiscalização do Recolhimento de Contribuições Previdenciárias	1	-
Ministério da Saúde	Melhoria Habitacional para o Controle da Doença de Chagas	1	225.000,00
	Bolsa-Alimentação	1	1.740,00
	Prevenção/Controle - Doenças Transmissíveis	1	64.272,00
	Atendimento Assistencial Básico	1	129.012,00
	Assistência Farmacêutica Básica	1	13.031,00
	Construção e Ampliação ou Melhoria dos Serviços de Abastecimento de Água Para Controle de Agravos	1	116.890,00
	PAB - Programa PACS	1	40.744,00
Ministério da Integração Nacional	Ações de Defesa Civil	1	300.000,00
Ministério do Trabalho e Emprego	Estudos e Pesquisas na Área do Trabalho	1	-
Ministério do Desenvolvimento Social e Combate à Fome	Atendimento à Criança em Creche ou Outras Alternativas Comunitárias	1	20.424,00
	Fome Zero	1	-
	Capacitação de Conselheiros, Gestores e Técnicos de Assistência Social	1	-
Ministério das Comunicações	Fiscalização da universalização dos serviços de telecomunicações – Nacional	2	-
TOTAL		**29**	**3.095.226,00**

Figure 4.10: Table Listing Audited Funds Continued

Ministério da Educação:

1.1) Irregularidades no uso de recursos do FUNDEF – Tomada de Preço 001/2003
1.2) Contratação temporária de professores sem respaldo legal
1.3) Irregularidade no pagamento de salários
1.4) Transporte escolar realizado em situação de risco para o usuário

Figure 4.11: List of Instances Identified

involved in corruption is 19.5%, which means that almost 20% of all audited funds were associated with an act of corruption.

Table 4.3 shows the correlation between my measure and Brollo's and AFF's (Avis, Ferraz and Finan 2018) data for the periods where there is overlap. Although these numbers may not seem too high, they are in line with other work which uses machine learning to categorize the audits (Muço 2019). Robustness checks using only Brollo and only AFF's data can be found in the Appendix, most of the results hold. However, my measure provides one consistent measure for

2.1) Falta de merenda escolar
2.2) Ausência de processo licitatório na aquisição de merenda escolar

Ministério da Saúde:

1.1) Recursos recebidos, porém não aplicados no programa da dengue

2.1) Falta de prestação de contas

Ministério do Desenvolvimento Agrário:

1.1. Realização de licitação sem projeto básico
1.2. Realização de obra sem projeto executivo
1.3. Valores das metas constantes no Plano de Trabalho e os valores contratados são coincidentes
1.4. Execução de obras sem efetividade
1.5. Execução de obras de 7 aguadas, todas iguais em termos quantitativos e qualitativos de serviços, porém em locais distintos

2.1 Dados da amostra inconsistentes

3.1 Exigência de reciprocidade bancária na aprovação de financiamento
3.2 Inexistência de fiscalização
3.3 Inexistência de comprovantes de despesas
3.4 Falta de assistência técnica

Ministério da Previdência Social:

1.1 Ausência de retenção e de recolhimento de contribuição previdenciária

Ministério da Integração Nacional:

1.1 Não disponibilização de informações pela Convenente
1.2 Não disponibilização de relação de beneficiários pelo Concedente

Ministério do Desenvolvimento Social e Combate à Fome:

1.1 Desvio de bens adquiridos com recursos federais

Figure 4.12: List of Instances Identified Continued

all the audits in the period, and I believe the classification of the corrupt instances in the year they happened, rather than the year they were identified and disclosed by auditors makes more sense in the type of corruption study I am undertaking in this dissertation.

Table 4.3: Correlation With Other Corruption Measures

	Fraction Corruption	Corruption Instances
Brollo	0.26	-
AFF	0.19	0.42

4.4 Defining Boom and Bust Elections

An important part of the theory is related to the electoral dynamics and corruption decisions which change whether we are in a boom or a bust period. Importantly, the expectations of whether oil royalties will be higher or lower in the following period as compared to the current period play a fundamental role in the incumbent's decisions to pool or not pool, in the decisions of citizens to run for office or not, and by extension, in voters' choices to reelect the incumbent or choose a challenger from the pool of candidates.

This means that defining whether an election can be classified as a boom election or a bust election becomes an important part of testing the theory. In order to determine whether an election is a boom or a bust, I compare the average price of oil the year before the election to the expected price of oil the year after the election, where the expected price of oil is proxied by the oil futures contracts deliverable in 6 months.[8]

The decision to use oil futures contracts follows from several different considerations. First, the price of oil follows a random walk, making it very difficult to theoretically determine how people form beliefs about the expected price in the future. Using actual contracts which represent the revealed belief of people who are actually willing to put down money on these expectations solves some of this theoretical uncertainty. Second, the futures contracts clearly reflect the mood around the oil sector at the time they are signed. For example, in periods where oil is booming and expectations of this to keep growing are high, the oil contracts are signed at higher prices reflecting this excitement in the industry. On the other hand, when there is a negative outlook with regards to the industry, oil futures contracts generally reflect this, and contracts are signed for lower

[8]Where I got this information from - .

Table 4.4: Defining Booms and Bust Elections

	Current Price	**Expected Price***	**Comparison**
2000 Election	≈ 0	\$25	$>$
2004 Election	\$41	\$56	$>$
2008 Election	\$99	\$61	$<$
2012 Election	\$94	\$97	$>$?

prices. This is strongly reflected in the late 2008 oil futures contracts. Finally, these contracts can be thought as incorporating all available market information, and so the prices of these contracts reflect expectations at the time in the best possible way that an empiricist looking back can get.

Table 4.4 shows the way in which I determine whether an election is a boom or a bust. In the Current Price column, we see the average price of a barrel of oil (WTI-USD/Barrel) for each election year. The price for 2000 is set to \$0 as an imputation given that in the Brazilian context, before 2000 municipalities received close to \$0 in royalty payments. We can see that the price of oil rises to \$41 in 2004, \$99 in 2008 and \$94 in 2012. The next column, Expected Price, represents the average price of oil futures contracts deliverable in six months. This is a proxy for the expectation of future royalties at the time of the election. Here we can see that it goes from \$25 in 2000 to \$97 in 2012. The column which determines whether the election is classified as a boom or bust is the final column: Comparison. Here, we compare the values in the first column to that in the second column. If the comparison is positive, i.e. the expected future royalties are higher than the current royalties, then we classify that election as a boom election. If, on the other hand, the comparison is negative, i.e. the expected future royalties are lower than the current royalties, then we classify that election as a bust.

From Table 4.4, we can see that the 2000, 2004 and 2012 election are classified as boom elections, although the 2012 election has a question mark on it given that the difference between \$94 and \$97 is very small making it a very slight boom. The 2008 election is classified as a bust election. This classification will be used in the next chapter, where I show results for the effects oil windfalls on corruption and reelection rates during booms versus bust elections.

4.5 Covariates

In this section, I present the set of covariates which I will use in order to control for any other confounding effects which may be present due to oil municipalities being different to non oil municipalities. Table 4.5 shows the list of covariates and their sources. The variables can be classified into three groups of variable types. First, we have a set of candidate characteristics for both incumbent candidates as well as for the challengers, we can call these politician variables. These variables include information on the party of the politician, the level of education which identifies whether they completed high school and college degrees, the gender of the politician, the age of the politician, etc. These variables are obtained from the Superior Elections Tribunal (TSE - Tribunal Superior Eleitoral) and vary at the candidate-term level.

The second group of variables corresponds to municipality characteristics. These include information on municipal GDP, the population of a municipality and the proportion of urban versus rural dwellers and the composition of production inside that municipality, for example, the proportion of GDP which corresponds to the industrial, agricultural and service sector. These variables also include information on the population of those municipalities. These variables include information on the educational levels of the people living in a municipality which is identified by literacy and schooling rates, as well as information on the living standards and level of informational attainment within households identified by variables such as the percent of households who own a television or a radio. These variables provide a picture of the socio-economic conditions in each municipality and represent important variation within our sample. Some of them vary at the municipality-year level, although for the purposes of this study I compute averages per term, thus creating a municipality-term variation. Other variables vary only at the municipality-decade level since they are obtained from the demographic census which is conducted every 10 years. For the purposes of this study, I use the information from the 2000 and 2010 census, the ones available to me in the time frame under study.

The final set of variables has to do with the government budgets and policies inside the

Table 4.5: Control Variables and Sources

Variable	Description	Source
Party	Party of the incumbent mayor	TSE (Superior Elections Tribunal - Tribunal Superior Eleitoral)
High School Education	Dummy variable for whether incumbent mayor completed a high school education	TSE (Superior Elections Tribunal - Tribunal Superior Eleitoral)
College Education	Dummy variable for whether incumbent mayor completed a college education	TSE (Superior Elections Tribunal - Tribunal Superior Eleitoral)
Female	Dummy variable for whether incumbent mayor is a woman	TSE (Superior Elections Tribunal - Tribunal Superior Eleitoral)
Municipal GDP	Municipality Gross Domestic Product	SIDRA IBGE
Population	Population in the municipality	IBGE Population Estimates
Percent Urban	Percent of the population living in urban areas	IBGE Population Estimates
Percent Rural	Percent of the population living in rural areas	IBGE Population Estimates
Industry	Percent of GDP that corresponds to the industry sector	SIDRA IBGE
Agriculture	Percent of GDP that corresponds to the industry sector	SIDRA IBGE
Services	Percent of GDP that corresponds to the industry sector	SIDRA IBGE
Percent TV	Percent of the population that own a television	Census (2000 & 2010)
Percent Radio	Percent of the population that own a radio station	Census (2000 & 2010)
Literacy Rate	Percent of the population that can read	Census (2000 & 2010)
Schooling	Average years of schooling of the population	Census (2000 & 2010)
Total Revenue	Total revenue received by the municipal government	FINBRA
Taxes	Total revenue from taxes received by the municipal government	FINBRA
Federal Transfers	Total revenue from federal transfers received by the municipal government	FINBRA
Total Expenditure	Total expenditure by the municipal government	FINBRA
Admin. Expenditure	Total administrative expenditure (mostly salaries) by the municipal government	FINBRA

municipalities. These variables contain information such as the total amount of government revenue available to mayors, the amount of this revenue that comes from federal transfers versus local taxes, the total expenditure of these municipalities as well as the composition of this expenditure and how much is spent on administration (mostly salaries) versus other expenditures. These are obtained from the Brazilian Treasury through their FINBRA (Finanças do Brasil) portal. These also vary at the municipality-year level but for purposes of this study, they are grouped into municipality-term level.

5 Reduced Form Results

Do oil windfalls hamper accountability? In the previous chapters I developed a theory that links oil windfalls to reduced accountability, which can be seen through its effects on reelection rates and corruption outcomes. In this chapter, I present results for the hypotheses derived from the model developed in Chapter 3. These hypotheses can be grouped into three groups: first are the hypotheses related to the effects if oil windfalls on corruption outcomes, second are those related to the effects of oil windfalls on reelection rates and third are the hypotheses related to the effects of oil windfalls on the honesty of the candidates entering into politics in oil affected municipalities during booms and busts. In this chapter, I present evidence for the first two groups of hypotheses, while I go more in depth into the third group of hypotheses on candidate entry in Chapter 6. This chapter also looks at the downstream effects that oil windfalls have on policy decisions. If oil windfalls affect the behavior of incumbents with regards to corruption decisions, then they may also change the way in which these politicians spend their funds. Although this is not a direct result of the theory, evidence that aligns with these predictions would make the findings more credible. I take several approaches to statistically testing these three groups of hypotheses, and present different specifications and robustness tests in order to assuage research design concerns.

Throughout the statistical tests, I find strong empirical evidence for the theoretical predictions of my model. Consistent with the theory, I find that municipalities that receive large offshore windfalls display higher levels of corruption on average. These effects are large and statistically significant. Everything else equal, I find that a one standard deviation increase in oil royalties leads to a 29% increase in the amount of funds found to be linked to corruption. Additionally, I find

that these effects follow the international price cycle as predicted by the theory. Corruption in oil affected municipalities is higher in terms after a boom election, while it is lower in terms after a bust election. These effects are also large and similar in magnitude to the average effect of oil on corruption.

With regards to the effects of oil on reelection rates, I find that these are affected in opposite directions depending on whether we are looking at a boom or a bust election. As predicted by the theory, oil windfalls lead to higher reelection rates for incumbents running for reelection during booms and lower reelection rates for incumbents running for reelection during busts. These effects are robust whether we look at our sample of municipalities for which there are audits or whether we look at the universe of Brazilian municipalities.

Additionally, I provide some evidence of the downstream effects of oil windfalls on spending outcomes. If oil windfalls affect incumbent politician's decisions to engage in corruption, they are probably also affecting the way in which these politicians spend their budgets. In particular, I look at the effects of oil on spending in areas that are more likely to get audited, health and education, where we would expect that if windfalls are leading to more corruption, they should also lead to a reduction in spending in these areas. I find strong evidence of this effect. I also look at the effect of oil windfalls on spending in areas where it is easier to engage in corruption, in particular, construction of housing and infrastructure. We know that in Brazil, construction is an industry where corruption proliferates due to the many opportunities to over-invoice for materials and services, engage in fraudulent procurement processes and generally collude with the construction companies. Accordingly, I find that windfall affected municipalities spend more on housing and infrastructure investments, which indirectly supports the finding that windfall affected municipalities engage in more corruption.

Finally, I test for alternative mechanisms such as informational effects. If voters do not observe windfalls, then the existence of these extra funds in government coffers could lead to more corruption and also more reelection through an economic voting channel. Under this alternative theoretical framework, only moral hazard would be at play, and there would be no incentive for

mayors to pool. Contrary to this alternative framework, I find evidence that the informational channel is not at play. In fact, access to more information only reduces corruption outcomes for second term mayors, where my theory would predict that moral hazard is the most important mechanism.

Taken together, the results in this chapter provide strong empirical support for the theory proposed in Chapter 3. I find that oil windfalls significantly reduce voters ability to hold their politicians accountable, and lead to higher reelection rates, corruption and more venal candidates running for office during booms. Oil windfalls also lead to important policy distortions which are likely part of the reason why oil municipalities have not been able to improve their socio-economic indicators despite the large amounts of funds available at their disposal.

5.1 Overview of the Data

All of the statistical tests in this chapter are conducted on data from Brazilian municipalities for the period between 2000 and 2016. This includes four municipal election cycles: 2000, 2004, 2008, and 2012, leading to four subsequent office holding periods: 2001, 2005, 2009 and 2013. Note that a mayor elected in any given year will only take office on the 1st of January of the following year. For example a mayor elected in 2000 will take office on the 1st of January of 2001 and serve until the 31st of December of 2004. The final dataset is a pooled-cross section of municipality-term observations, where municipalities only enter into the dataset if they have been selected for auditing. This dataset is comprised of 3,584 municipality-term observations, 2,823 of which are for non oil municipalities while 761 are for oil municipalities.

Table 5.1 shows the summary statistics for this dataset, differentiating by whether a municipality is a royalty receiver (Oil) or not (Non Oil). The mean levels of corruption appear to be higher in oil municipalities, where corruption reaches 21.6%. In non oil municipalities, corruption is about 14.8%. Oil municipalities are also larger, richer and more urban, which makes sense given that they are mostly coastal cities which tend to be richer and more populous in Brazil.

Table 5.1: Balance between Oil and Non Oil Municipalities in Sample

	(1)	(2)	(3)
Variable	Non Oil	Oil	Difference
Corruption	14.797	21.583	6.787***
	(21.792)	(27.578)	(0.945)
PMDB	0.190	0.163	-0.027*
	(0.392)	(0.370)	(0.016)
PSDB	0.131	0.120	-0.011
	(0.338)	(0.325)	(0.014)
PT	0.064	0.075	0.010
	(0.246)	(0.263)	(0.010)
PTB	0.061	0.043	-0.018*
	(0.239)	(0.204)	(0.009)
Term Limited	0.240	0.280	0.040**
	(0.427)	(0.449)	(0.018)
Highscool Education	0.775	0.842	0.068***
	(0.418)	(0.365)	(0.017)
College Education	0.487	0.556	0.069***
	(0.500)	(0.497)	(0.020)
Industry	0.132	0.132	0.000
	(0.000)	(0.000)	(0.000)
Agriculture	0.491	0.491	0.000
	(0.000)	(0.000)	(0.000)
services	0.085	0.085	0.000
	(0.000)	(0.000)	(0.000)
Municipal GDP	682869.688	2.989e+06	2.306e+06***
	(5.722e+06)	(2.617e+07)	(537662.500)
Population	34,229.953	79,907.078	45,677.129***
	(115370.562)	(459617.531)	(9,665.949)
Percent Urban	0.605	0.639	0.033***
	(0.232)	(0.225)	(0.010)
Percent Rural	0.395	0.361	-0.033***
	(0.232)	(0.225)	(0.010)
Female	0.061	0.087	0.025**
	(0.240)	(0.282)	(0.010)
Total Revenue	0.098	0.098	0.000
	(0.000)	(0.000)	(0.000)
Taxes	0.055	0.055	0.000
	(0.000)	(0.000)	(0.000)
Federal Transfers	0.232	0.232	0.000
	(0.000)	(0.000)	(0.000)
Total Expenditure	0.100	0.100	0.000
	(0.000)	(0.000)	(0.000)
Admin Expenditure	0.182	0.182	0.000
	(0.000)	(0.000)	(0.000)
Observations	2,823	761	3,584

Throughout this chapter, the analysis is restricted to municipalities in coastal states, in an effort to reduce differences between non coastal state municipalities and since offshore oil windfalls are only distributed to coastal municipalities. In the following sections, I present reduced form results testing the hypotheses laid out earlier. Most of the analysis consists of simple ordinary least squares regressions with state and time fixed effects, given that the data is a pooled cross section, I am unable to include municipality fixed effects which would be the preferred specification. In all regressions, I will also control for all relevant variables which may capture any systematic differences between oil and non oil municipalities. These include population size, municipal GDP, measures the size of different economic sectors, candidate characteristics such as party, education and gender, and characteristics of the municipality such as the amount of federal transfers, tax revenue etc. It is worth mentioning that given the geographic rule of royalty allocation, sometimes two neighboring municipalities which have very similar characteristics will differ greatly on the amount of royalties received, which makes the strategy of identification more sound.

5.2 The Effect of Royalties on Corruption

Do oil royalties lead to higher corruption? A preliminary analysis of the data shows that the levels of corruption found in royalty receiving municipalities is higher than the levels of corruption in non royalty receiving municipalities. Figure 5.1 shows the difference in the distribution of corrupted funds between oil municipalities and non oil municipalities, where oil municipalities are classified as those municipalities which received offshore royalties in the period. The distribution for oil municipalities is skewed to the right when compared to non oil municipalities, which indicates that there is higher levels of corruption in municipalities which are receiving offshore royalties.

In order to test whether the difference in corruption levels between royalty receiving municipalities and non royalty receiving municipalities is robust to the addition of controls and other municipal characteristics, I turn to regression analysis. Ideally I would want to run a panel regression using municipality fixed effects, but since my data is a pooled cross section, I conduct the following

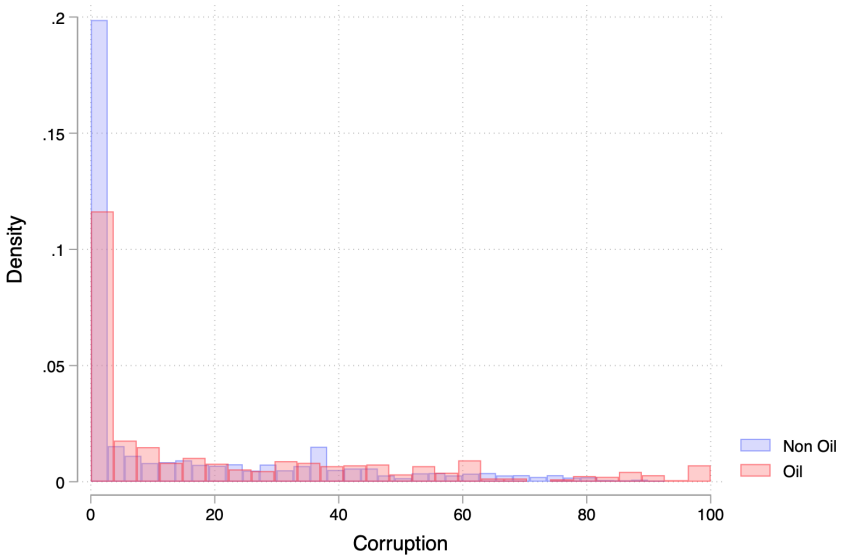


Figure 5.1: Corruption in Oil and Non Oil Municipalities

regression:

$$C_{i,t} = \alpha_1 R_{i,t} + X'_{i,t}\beta + \varepsilon_s + \varepsilon_t + \mu_{i,t} \tag{5.1}$$

Where C_i represents the level of corruption in municipality i, during term t measured as the fraction of the funds received during term t which where used in a corrupt way. $R_{i,t}$ represents a variable measuring royalties. $X'_{i,t}$ represents control variables which may influence the level of corruption, such as the amount of federal funds and local taxes received, as well as mayor characteristics such as education, gender and party, $\varepsilon_s, \varepsilon_t$ are state fixed effects and term fixed effects $\mu_{i,t}$ is an idiosyncratic error. Errors are clustered at the state level.

This regression is run with three measures of $R_{i,t}$: (i) an indicator, "Oil Municipality", for whether the municipality was a royalty receiving municipality in that term, (ii) a variable which measures the standardized amount of royalties received, and (iii) the natural logarithm of royalties received. All regressions include state, lottery and term fixed effects. Standard errors are clustered at State level.

The results are presented in Figures 5.2 and 5.3. For each independent variable $R_{i,t}$, the dark

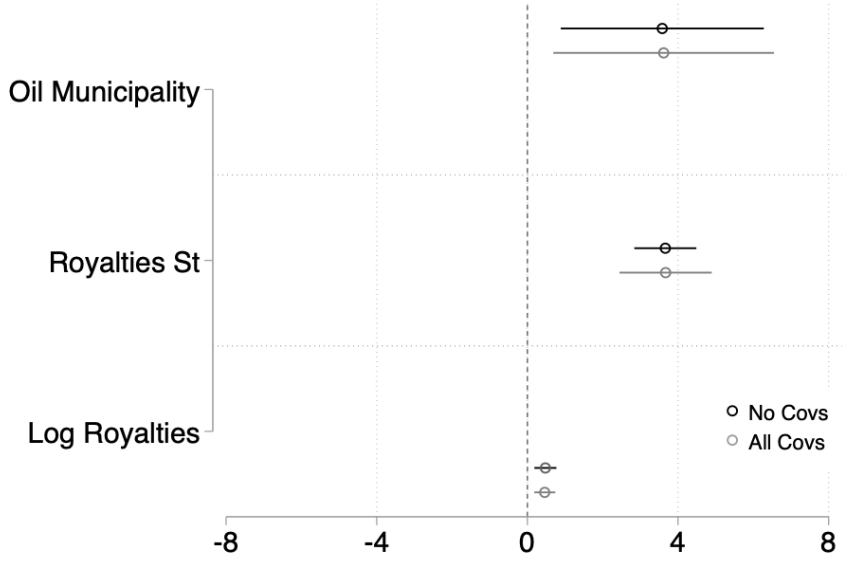


Figure 5.2: Effect of Royalties on Corruption: Dependent Variable is Fraction of Funds Used in a Corrupt Way in Each Municipality-Term.

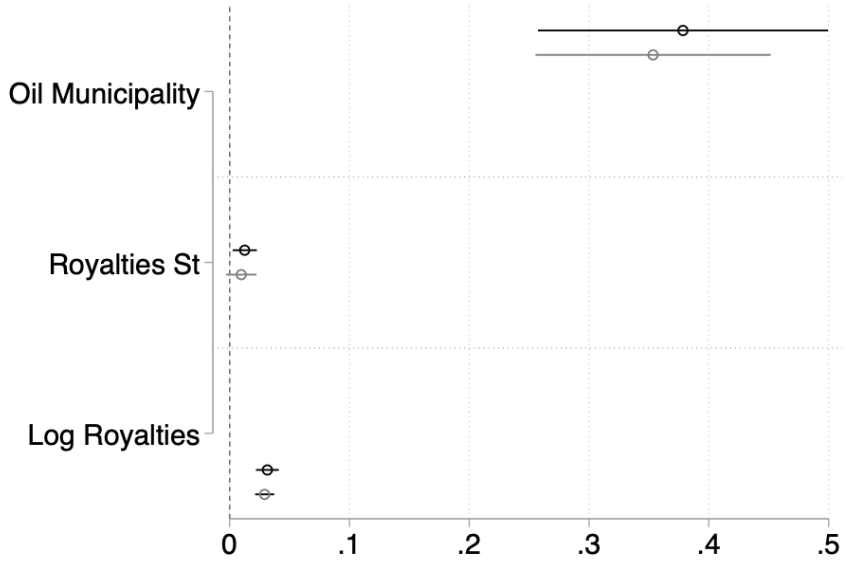


Figure 5.3: Effect of Royalties on Corruption: Dependent Variable is Indicator For Whether Corruption was Identified in this Municipality-Term.

gray coefficient is from a model only with state and term fixed effects and the light gray coefficient is from a model which includes relevant covariates such as population, GDP, federal transfers, income from taxes, whether the incumbent was college educated, female, term limited, and political party indicators. Figure 5.2 shows the effects of our three measures of royalties on the percent of funds used in a corrupt way, while Figure 5.3 shows the effect of the measures of royalties on an indicator which takes the value of 1 if any corrupt acts are identified within a municipality-term. The full regression results can be found in Tables 8.2 and 8.3 in the appendix.

The coefficient on royalties is positive and significant for all specifications, indicating that municipalities that receive higher royalties display higher levels of corruption. The coefficients of the indicator variable suggest that royalty receiving municipalities display about 3.6% more funds used in a corrupt way than their non royalty receiving counterparts. Considering that the average level of corrupt funds is 20%, this is a sizable effect. Similarly, oil municipalities are about 36% more likely to present at least one corrupt instance within the audits. This is the extensive margin, i.e. whether you receive royalties or not.

When we look at the intensive margin, i.e. how much royalty income a municipality receives, the effects are also significant and large. A one standard deviation increase in royalties leads to about a 3.7% increase in corruption. The results for the corruption indicator shown in Figure 5.3 show that a one standard deviation in royalties leads to only a 1% probability increase in the likelihood of having a corrupt instance, which demonstrates that the effects found are likely to be driven by municipalities that receive a lot of funds and display significantly higher levels of corruption. Again, this is shown by the coefficients for the Log Royalties variable, where a 1% increase in royalties leads to a 0.5 percentage point increase in corruption. This means a 10% increase in royalties would lead to 5% more of the audited funds being used in corrupt acts, which can be considered a sizable effect. Finally, the coefficients for Log Royalties in Figure 5.3 shows that a 1% increase in royalties leads in increase of about 3% in the likelihood of having at least one corrupt instance in the term.

Term limited mayors appear to be more corrupt in most intensive margin specifications, however do not show any significance on the extensive margin (see Table 8.3 in Appendix). This is

in line with the results found by Ferraz and Finan (2011), and is also in line with the predictions of my model. Political parties do not appear to be significant. Furthermore, most of the controls do not appear to be significant except for the model with coastal municipalities only where municipalities with higher total revenue (excluding oil royalties) appear to be less corrupt, municipalities with higher federal transfers appear to be less corrupt and municipalities with higher total expenditures are more corrupt. The size of these effects is smaller (but similar) to the effects of oil rents.

Figure 5.4 shows the differential effects of royalties on first versus second term mayors. Dark gray coefficients correspond to first term mayors while light gray coefficients correspond to second term mayors. The first two coefficient show the effects of the royalty indicator variable, the 3rd and 4th coefficient show the effects of the standardized royalty variable and the 5th and 6th coefficient show the effects of the log royalties variable. We can see that the effect of royalties is larger on second term mayors than first term mayors for all measures of royalties. This is likely showing the fact that second term mayors no longer face reelection, and so they are not trying to pool in order to get reelected. These results suggest that the selection effect identified in the model is probably taking place, when there is a lot of money to be stolen, second term mayors who face no accountability from a future election prospect will steal more money than first term mayors, who are somewhat restricted by the possibility of gaining office in the future.

5.3 The Dynamic Effect: Booms versus Busts

The theory predicts that it is not just the amount of royalties received, but the expected royalties that matter for determining rent extraction and reelection rates. In order to test these hypotheses, first I show that royalties are highly correlated with the international price of oil, as can be seen in Figure 5.6. This validates the choice of using expected prices of oil as a measure of expectation of future royalties in royalty receiving municipalities. Figure 5.5 shows what royalties looked like during each election, which is marked with a dashed line. Additionally, Figure 5.7 shows the evolution of the price of Cushing Oil Futures contracts and elections, marked with a

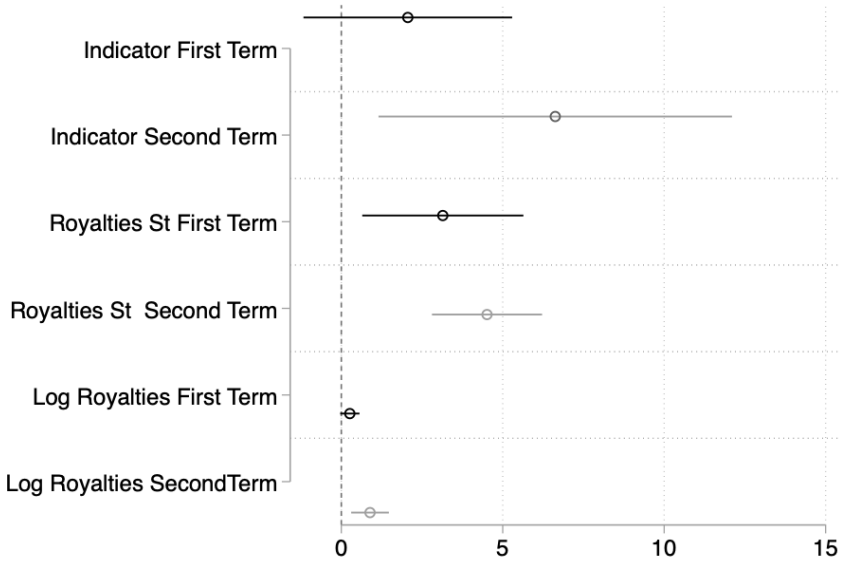


Figure 5.4: Effect of Royalties on Corruption: First Term versus Second Term Mayors. Dependent variable is Fraction of Audited Funds Identified as Involved in Corruption (0-100)

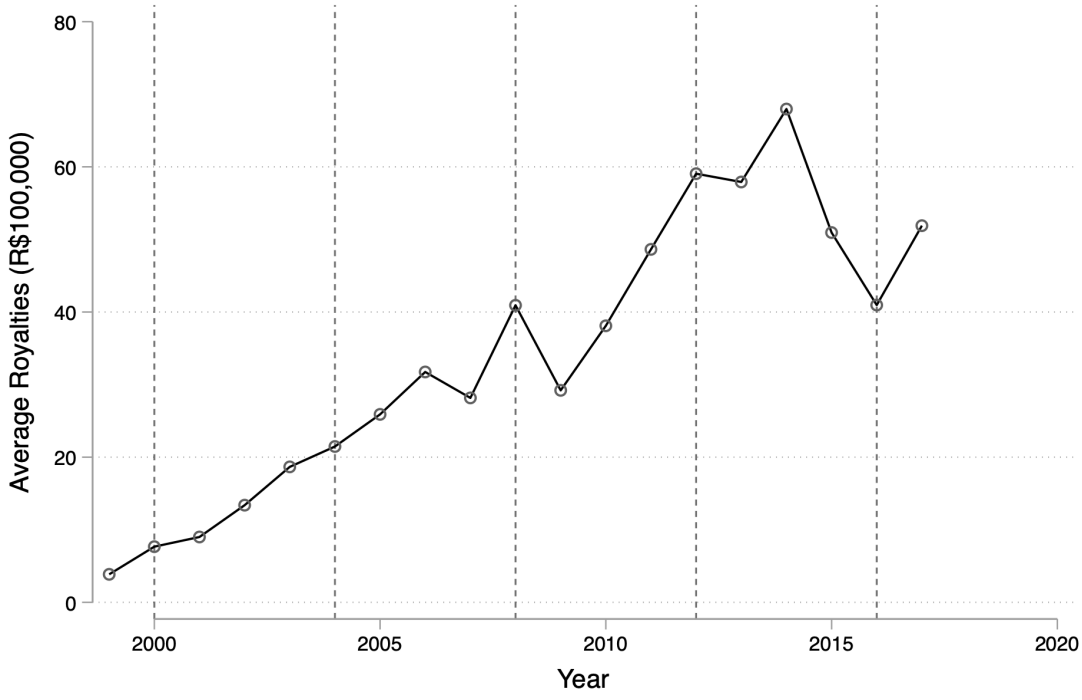


Figure 5.5: Royalties and Timing Elections. Dashed lines represent dates of Municipal Elections.

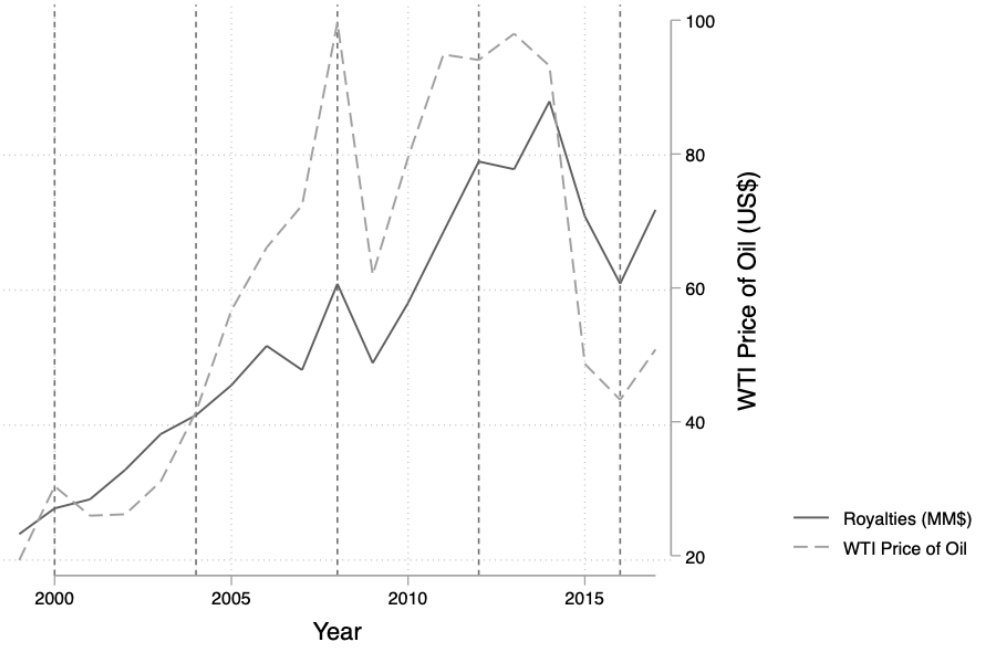


Figure 5.6: Royalties Distributed to Municipalities and International Price of Oil

dashed line.

Given these dynamics in the oil price and the distribution of royalties, I classify the 2000, 2004 as booms, and the 2008 and 2016 elections as busts since the average amount of royalties during the period (Ω_1) is lower than the expected royalties at the date of the election ($E(\Omega_2)$), as measured by the futures contracts seen in Figure 5.7. The 2012 election is difficult to classify since Ω_1 is similar to $E(\Omega_2)$, although the constant rise in royalties could lead us to classify it as a boom election.

In order to test whether the price of oil has an effect on corruption outcomes, I run the following event-study style regression:

$$C_i = \alpha T_i * R_i + \beta T_i + X_i' \beta + \varepsilon_s \tag{5.2}$$

where R_i is a royalty indicator, T_i is the term after the election, X_i' corresponds to a vector of covariates and ε_s corresponds to state fixed effects. Errors are clustered at the state level. The main coefficient of interest here is α, the coefficient on the interaction between the royalty variable

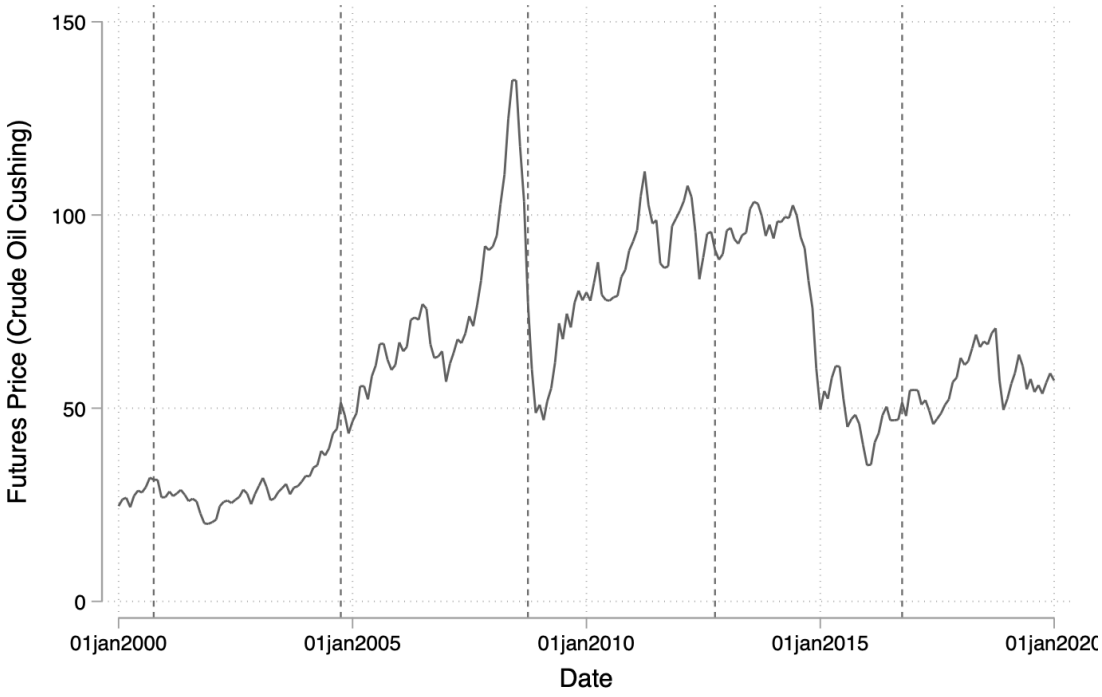


Figure 5.7: Oil Futures Prices and Elections

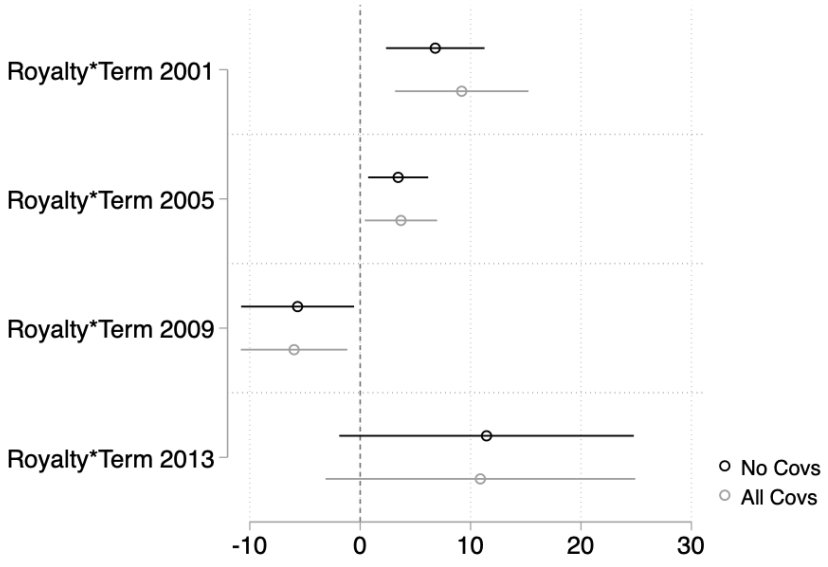


Figure 5.8: Effect of Royalties on Corruption, by Term

(which represents the oil shock) and the term variable. Following the comparative statics in Table 3.3 and the hypotheses laid out above, I expect this to be positive for terms after elections held during booms and negative for elections being held during busts. Figure 5.8 shows the results of this regression. Dark gray coefficients correspond to the specification without covariates, while light gray coefficients correspond to the specification controlling for relevant covariates such as population, GDP, revenue from taxes, federal transfers and mayor characteristics such as gender, political party and education. The full regression results can be found in Table 8.4 in the Appendix.

Figure 5.8 shows that going from royalty receiving municipalities had between 6.8% and 9.2% higher corruption levels in the term following the 2000 election (depending on whether covariates were used or not). Similarly, the effect was between 3.4% and 3.7% for the term after the 2004 election. Since both of these elections are considered boom elections, these results confirm our hypotheses. The term after the 2008 election, however, shows a negative coefficient which varies between -5.7% and -5.9%. This means that during the period after the 2008 election, royalty receiving municipalities displayed lower levels of corruption. This could have been driven by the selection effect: the bust led to many corrupt incumbents being kicked out together with an improvement in the pool of candidates, which ends up producing lower levels of corruption in the term after the election. The results for the period after the 2012 election are positive but not significative, which could be due to the fact that the "boom" during this election was not very significant, since Ω_1 was similar to $E(\Omega_2)$.

5.4 The Effect of Royalties on Reelection Rates

The model also predicts that reelection rates will vary depending on royalties and expected income from royalties. Incumbents will be more likely to be reelected when the price of oil is high and expected to keep rising (booms), while they will be less likely to be reelected when the price of oil is expected to fall (busts).

Given the comparative statics and hypotheses derived, and using the price variation in the

time periods presented in Figures 5.6, 5.5 and 5.7, I expect royalties to have a positive effect on reelection rates in the 2000 and 2004, while I expect a negative effect on reelection rates in 2008 and 2016. I am agnostic on the effects during the 2012 election given the very subtle boom which has been discussed above. Figures 5.9 and 5.10 show the result of running the regressions for each election year. Figures 5.9 shows the results of running the regressions on the full sample of municipalities, while Figures 5.10 runs the same regression only on the municipalities for which we have corruption data, to check that the results hold for our corruption random sample. The main dependent variable is Log Royalties/10, so that the coefficients represent the effect of a 10% increase in royalties. The large sample regressions include all relevant covariates, municipal and term fixed effects and clustered SEs at the municipal level. The small sample regressions include all relevant covariates. The full results of the regression can be found in Tables 8.6 and 8.7 in the Appendix.

As hypothesized, royalties have a positive effect on reelection rates for the 2000 and 2004 election and a negative effect for the 2008 and 2016 election. The positive but insignificant result for the 2012 election is, again, not surprising. For the 2000 election, the effect of a 10% increase in royalties leads to a 6.1% increase in the chance of reelection, while in 2004 it leads to a 3.5% increase in the chance of reelection. For the 2008 election, a 10% increase in royalties leads to a 4.1% reduction in the chance of reelection. The effect for the 2012 election is not significant, while the effect for the 2016 election is a 3.1% decrease in the chance of reelection. The baseline level reelection rates is close to 20%, so these effects are quite significant. The effects are similar for the small sample, although the negative effects for the 2008 election are not significant.

Another way of testing the hypotheses in the model has to do with the likelihood that an incumbent who can run for reelection actually runs. Figure 5.11 shows the results of similar regressions to those above but using an indicator for whether eligible incumbents ran for reelection or not. If we believe the story that incumbents pool during booms and don't during busts, then, on average, incumbents should be more likely to run for reelection during booms in the hopes of winning reelection, while they may steal everything in their first period and not run for reelection at

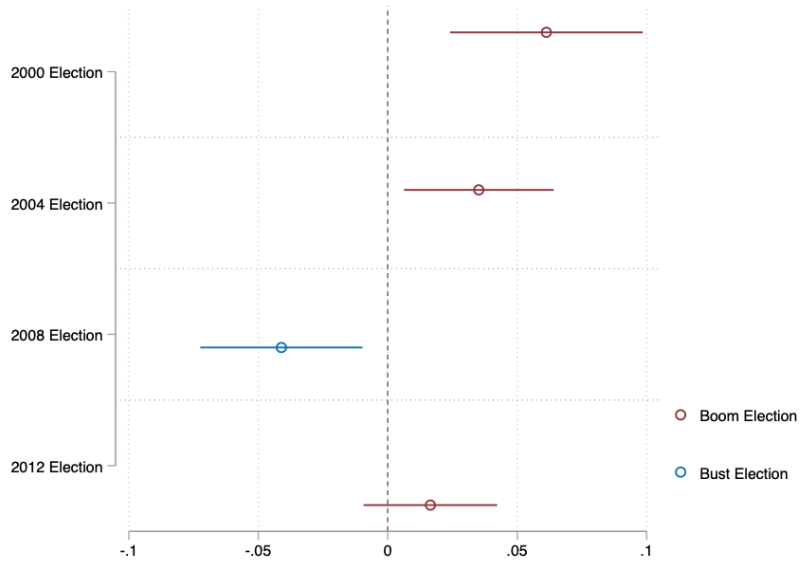


Figure 5.9: Effects of Royalties on Reelection Rates, By Election. Full Sample

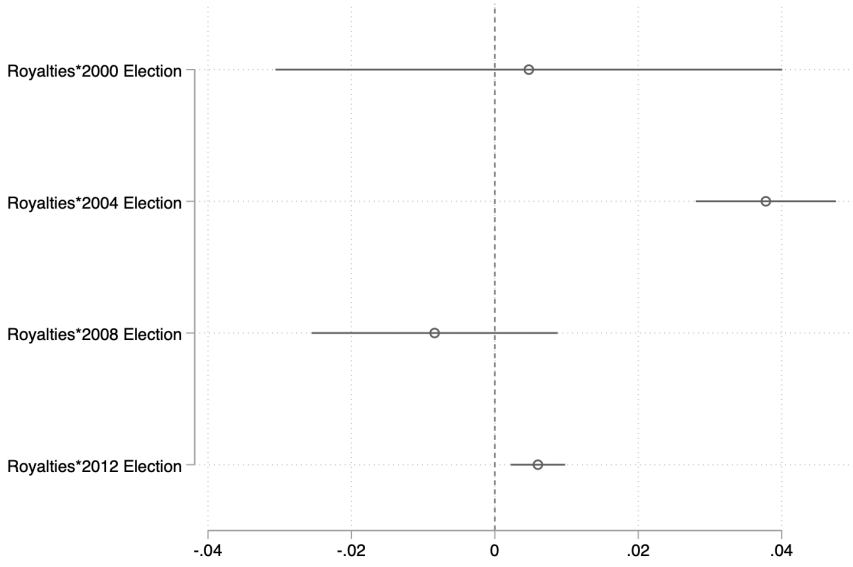


Figure 5.10: Effects of Royalties on Reelection Rates, By Election. Small Sample

all.

The results seem to support this hypothesis. a 10% increase in royalties leads to a 5.3% increase in the likelihood of running for reelection during the 2000 elections and a 4.1% increase in the likelihood of running for reelection during the 2012 elections. The baseline level of running for reelection is close to 30%, so these effects are quite significant. The effects are positive but not significant for the 2004 election. The effects are negative and significant for the 2008 elections, showing that mayors may not be running for reelection as often during this bust.

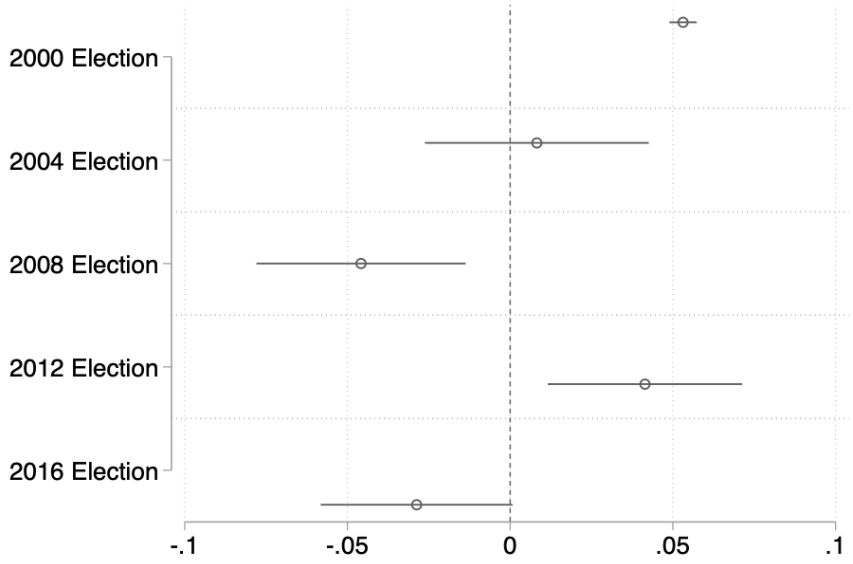


Figure 5.11: Effect of Royalties on Likelihood of Incumbent Running for Reelection, By Election. Large Sample

Overall, the results in this section confirm the predictions from the model laid out in H2 and H2.b. During booms, royalties lead to higher reelection rates of incumbents and a higher likelihood of the incumbent running for office. During busts, the opposite is true, reelection of the incumbent becomes less likely, and incumbents are less likely to run for reelection. The model would predict that the incumbents not running for reelection are choosing to extract maximum rents in their first period and forfeit reelection, since the expected rents in period 2 are not worth the sacrifice of pooling in the first term. In other words, during booms we observe more of a pooling equilibrium, while during busts the separating equilibrium is more likely.

5.5 Robustness: Covariate Balancing

One concern might be the fact that royalty receiving municipalities are richer, larger and more populous than the average municipality in Brazil. We can see that this is somewhat true in Table 5.1. Although the exogenous allocation of royalties through the geographic rule and the use of controls such as GDP and population should be enough to put away these concerns, in this section I run an extra robustness test by using entropy balancing and inverse probability weighting in order to ensure that the effects are robust to choosing control units which are similar to the treated units. The results are presented below. Most results hold up and remain significant, which can make us even more confident that the effects of oil on corruption and reelection are robust.

In this section, I first conduct an entropy balancing exercise. According to Hainmueller, "*entropy balancing relies on a maximum entropy reweighting scheme that calibrates unit weights so that the reweighted treatment and control group satisfy a potentially large set of prespecified balance conditions that incorporate information about known sample moments. Entropy balancing thereby exactly adjusts inequalities in representation with respect to the first, second, and possibly higher moments of the covariate distributions. These balance improvements can reduce model dependence for the subsequent estimation of treatment effects. The method assures that balance improves on all covariate moments included in the reweighting.*" (Hainmueller 2012). Table 5.5 shows the results of balancing on the mean, variance and skewness of the control variables which are significant in different specifications. We see that the post balance control groups are very similar to the treatment groups. Figures 5.12 - 5.14 show the results after balancing, which are mostly robust to the entropy balancing exercise.

Table 5.2: Entropy Balancing

	Treat			**Control: Pre Balance**			**Control: Post Balance**		
	mean	variance	skewness	mean	variance	skewness	mean	variance	skewness
GDP	.0744	3.809	23.46	-.05348	.02304	9.325	.07456	.1519	2.546
Population	.1571	4.464	19.9	-.05093	.1338	8.891	.1576	.4731	3.454
Rural	.3554	.05105	.2318	.4236	.05767	.04303	.3554	.06505	.2604
Total Revenue	.07929	3.814	23.33	-.04933	.0335	9.742	.07945	.1807	2.584
Taxes	.07229	4.55	24.08	-.03927	.008162	10.96	.07235	.1293	2.869
Federal Transfers	.1089	1.678	13.57	-.07014	.266	11.32	.1094	.5014	3.134
Term Limited	.2843	.2038	.9564	.2537	.1895	1.132	.2843	.2036	.9565
Highschool	.8215	.1469	-1.679	.7723	.1759	-1.299	.8215	.1467	-1.679
College	.5041	.2504	-.01653	.4566	.2483	.1744	.5041	.2504	-.01653
Female	.09752	.08816	2.713	.06638	.06201	3.484	.09751	.08805	2.714

Table presents results from entropy balancing. Left panel represents moments for treated units.
Middle panel represents moments for control units before balancing is performed, while right panel presents moments after entropy balancing is performed.

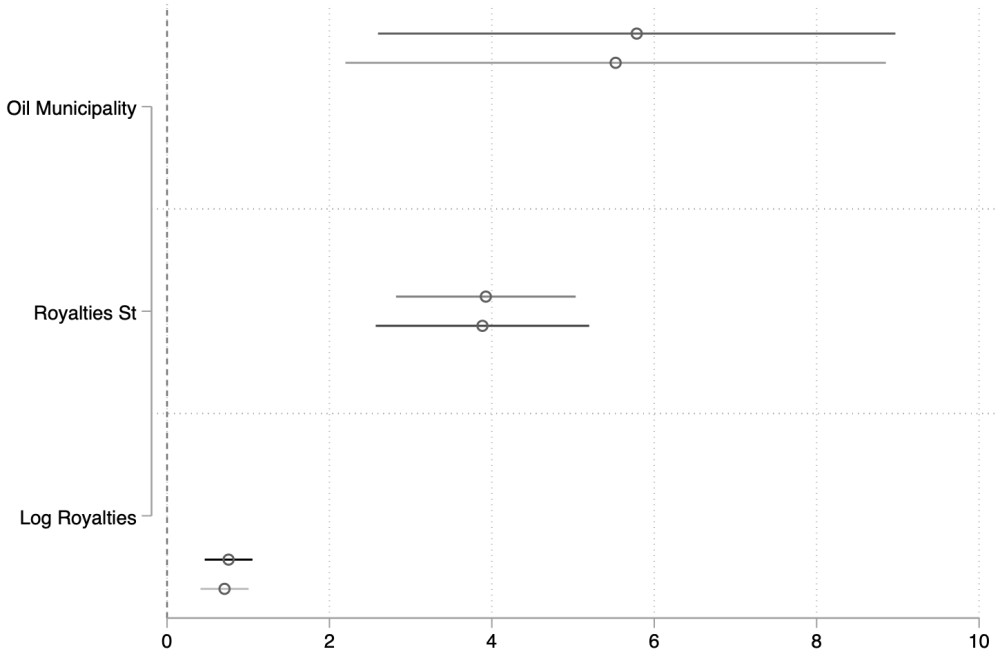


Figure 5.12: Entropy Balanced: Effects of Royalties on Corruption

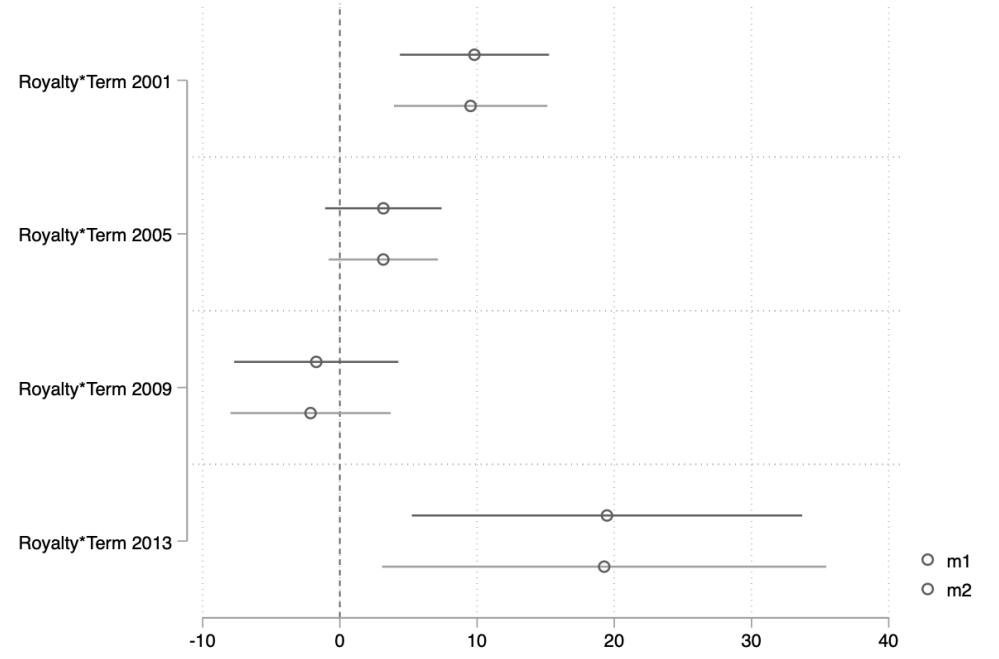


Figure 5.13: Entropy Balanced: Effects of Royalties on Corruption By Term

The second robustness check involves using kernel matching and inverse probability weight-

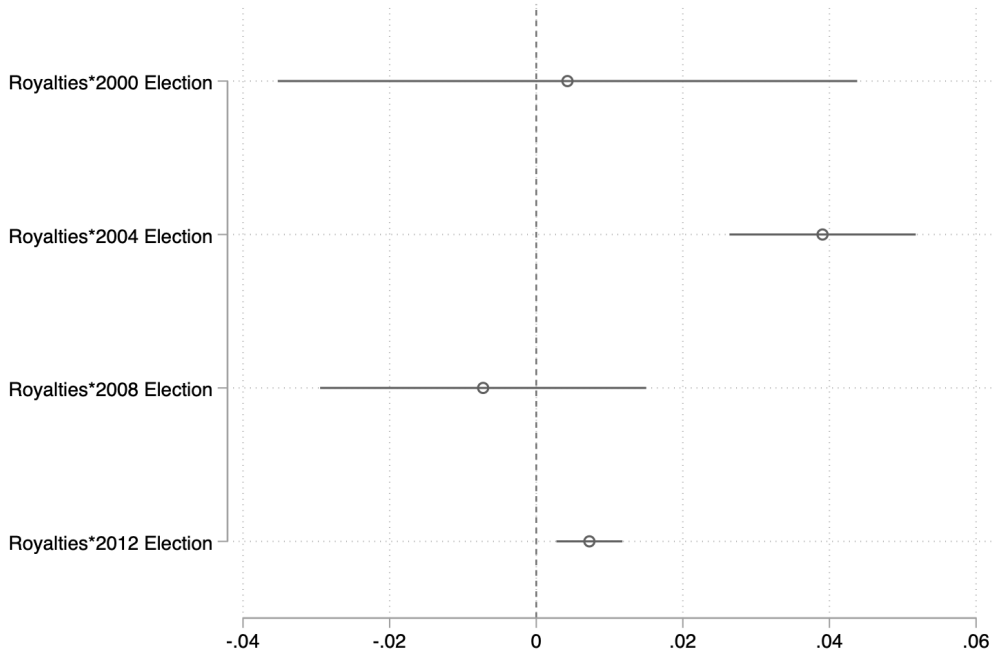


Figure 5.14: Entropy Balanced: Effects of Royalties on Reelection By Term

ing, instead of entropy balancing. Figure 5.15 and 5.16 show the results of this exercise. Figure 5.15 shows the effects of oil windfalls on average corruption throughout the four terms, where I report the results not only the inverse probability weighting but also the multivariate distance matching and propensity score matching. Figure 5.16 shows the effects of oil windfalls on corruption by term, once we conduct the inverse probability weighting. The results presented remain in the same direction and similar magnitude as those presented in the sections above, and they are also all significant.

5.6 Alternative Mechanisms: Voter Information

An alternative explanation which could lead to similar outcomes for corruption and reelection has to do with the unobservability of oil windfalls on behalf of voters. In fact, much of the oil curse literature has focused on the lack of transparency in the oil industry and its revenues, arguing that this is one of the mechanisms through which oil revenues affect democratization (Ross 2012; Paler

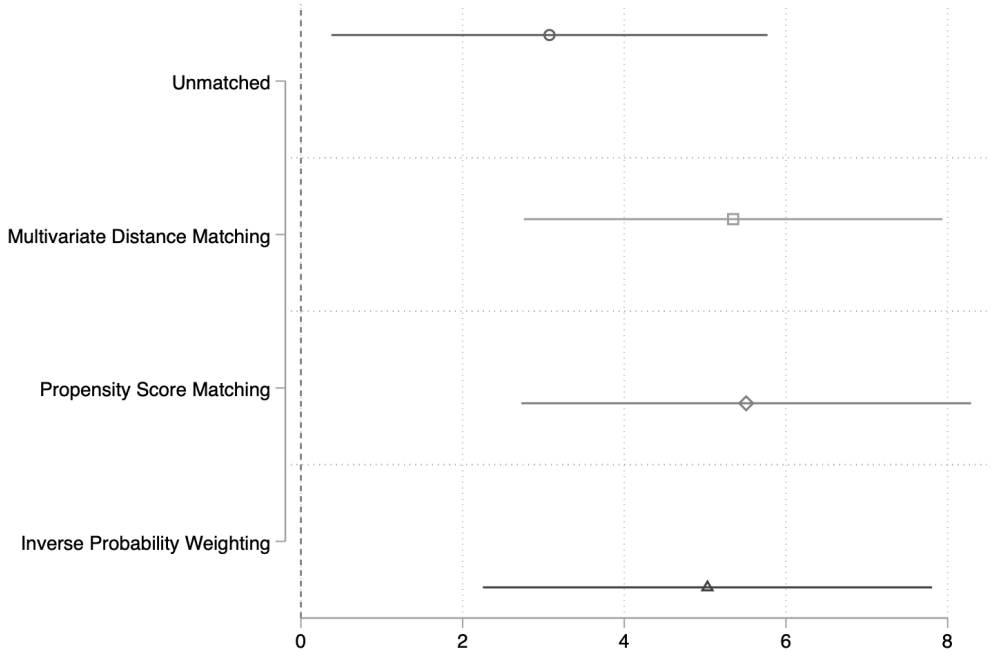


Figure 5.15: Kernel Matching: Effects of Royalties on Corruption

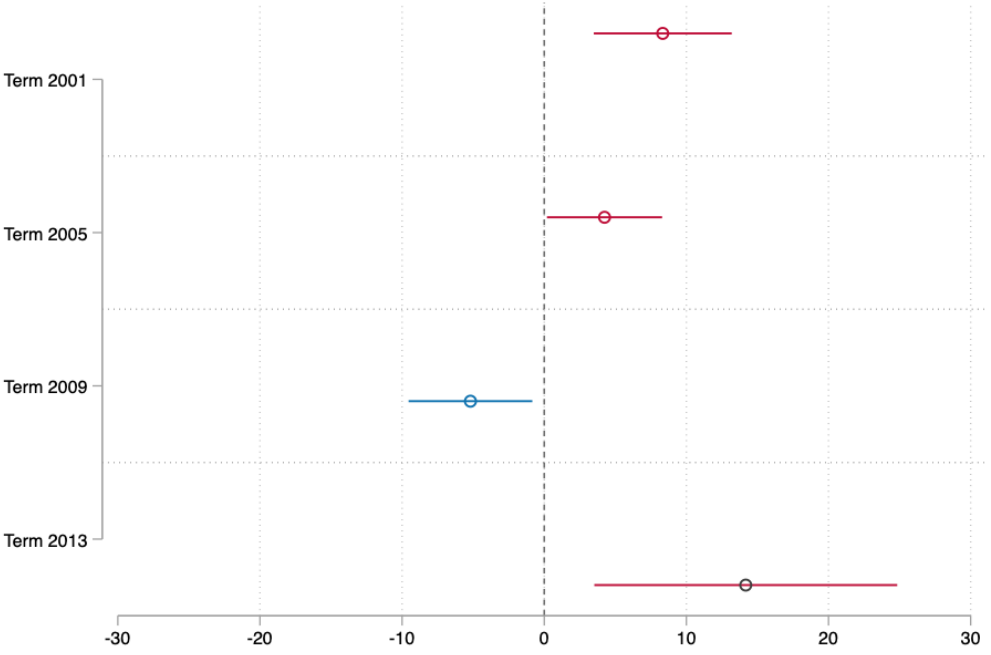


Figure 5.16: IPW: Effects of Royalties on Corruption by Term

2013). The argument generally goes: if voters do not observe windfalls due to lack of transparency, then the existence of these extra funds in government coffers could lead to more corruption and

also more reelection through an economic voting channel. In other words, voters will attribute good economic outcomes and higher government spending to the government's choices rather than the external source of windfalls, and thus voters' decisions become decoupled from government performance, thus hindering accountability.

Under this alternative theoretical framework, only moral hazard would be at play: since government performance does not directly affect voters' decisions to reelect, governments, the agents, have no incentive to work for the desires of the voters, the principals. This means that there would be no incentive for mayors to pool, since it is a pure moral hazard story and voters' can't really infer anything observing behavior, since they don't have information on the windfalls anyways. From my observation of the Brazilian case and my fieldwork in oil municipalities in the state of Rio de Janeiro, I believe this theoretical framework is unlikely to capture the Brazilian reality. There is intense coverage by local media of the royalties received by municipalities, since these usually represent a large fraction of the government budget, in some cases reaching two thirds of the total municipal budget. Furthermore, there has also been national coverage of some extreme cases, such as Presidente Kennedy and other oil rich municipalities, asking: where has the revenue gone? [1]

However, in order to discard this alternative mechanism, in this section I run a series of tests using proxies for voter information in order to rule out this alternative mechanism. The idea here is that if there is more exposure to news from either television, radio stations and local media in general or a more informed, educated public, then this should help decrease the lack of transparency that windfalls generate. If the mechanism leading to the observed corruption outcomes is the information mechanism, we should see the effect of royalties on corruption dampened by the presence of more informed voters.

Table 5.3 shows the results of interacting different information proxies with royalties. In

[1]ESTV 2a Edição May 17, 2018: "Apesar da arrecadao de Presidente Kennedy com os royalties, população não vê melhorias" (Despite revenues from royalties, Presidente Kennedy's population does not see improvements https://globoplay.globo.com/v/6743899/; Fantástico episode April 12, 2015: "Cidades com maior arrecadação por habitante têm serviços precários" (Cities with the highest revenue per capita have precarious public services) http://g1.globo.com/fantastico/noticia/2015/04/cidades-com-maior-arrecadacao-por-habitante-tem-servicos-precarios.html

Table 5.3: Heterogeneous Effects of Royalties on Corruption by Information Exposure

DV is Corruption	(1) % Tv	(2) % Radio	(3) Literacy Rate	(4) Schooling
Panel A: All Mayors				
Royalties St	19.37*	11.87***	11.95**	23.42***
Information	-11.69	-7.755	-23.22	-2.171
Royalties St × Information	-18.03*	-9.291*	-25.45***	-1.961**
Observations	2210	2210	2210	2210
R-Squared	0.295	0.297	0.295	0.298
Panel B: First Term Mayors				
Royalties St	1.616	9.352	8.786	6.782
Information	-7.813	-11.53	-27.89	-2.694*
Royalties St × Information	3.194	-5.476	-5.395	-0.511
Observations	1632	1632	1632	1632
R-Squared	0.310	0.309	0.312	0.312
Panel C: Second Term Mayors				
Royalties St	15.33***	25.77**	34.59***	17.79***
Information	-10.31	-26.52	-14.24	-2.307
Royalties St × Information	-13.90**	-26.30**	-40.85***	-3.588**
Observations	578	578	578	578
R-Squared	0.294	0.297	0.302	0.299

Information represents the variable indicated in each column header.

Sample includes only municipalities for which we have Corruption data.

Includes state and term fixed effects. State level clustered SE.

All regressions include controls.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

order to capture how informed voters in a municipality are, I use four different variables from the census: (1) the proportion of households who own a TV (column 1), (2) the proportion of households who own a radio (column 2), (3) the literacy rate (column 3) and (4) the average years of schooling for people in that municipality (column 4). All of these variables are measured in 2000. Panel A shows the results of interacting royalties with the information proxies for all the observations, while Panel B shows the results only for first term mayors, and Panel C shows the results for second term mayors. The results from Panel A suggest that the information mechanism might be generating the results, since there is a strong negative effect of the interaction term between information and royalties. However, once we divide the sample on whether the mayors are first or second term, we can see that the effects of information are driven by second term mayors, and are not significant for first term mayors.

This is more in line with my theory presented above. The fact that information is only relevant for second term mayor shows that informed voters have an effect on the maximum amount that politicians can steal, $\bar{s}$, and are thus leading to lower corruption rates in the second term. However, informed voters do not seem to have an effect on corruption in the first term, s_1. In other words, information does not affect an incumbent's pooling decisions, λ, which is in line with the model. This evidence suggests that informed citizens likely gain information on public spending and are more effective at monitoring politicians, however, the fact that the effects are not significant for first term mayor suggest that the unobservability of oil windfalls is not the reason we see the reelection and corruption cycles.

5.7 Downstream Effects: Do Windfalls Affect Policy?

Hoy do oil windfalls affect public policy? If we expect windfalls to affect outcomes such as corruption and reelection rates, it is only natural to expect them to also alter policy decisions made by incumbents. Furthermore, the ways in which these decisions are affected can help us strengthen our understanding of how and whether windfalls do affect corruption. In this section

I turn to municipal expenditures in order to analyze whether municipalities that are affected by windfalls have different spending patterns than those not affected by windfalls. The analysis of municipal expenditures can help in two main ways: first, it can help rule out some of the alternative mechanisms that could be driving our results, namely clientelism and patronage; second, if spending is going towards activities where it is easier to embezzle funds and harder to detect corruption, it can help confirm the main findings of the dissertation.

One of the main competing hypotheses for the electoral and corruption cycles we observe in royalty receiving municipalities has to do with the fact that mayors may be using the money from royalties to buy votes. This could appear as higher corruption and as higher reelection rates in municipalities with royalties when the price of oil is high (so royalties are high), but would result in mayors not actually pocketing the funds for themselves. This practice whereby politicians spend funds in a targeted way in exchange for votes is known as clientelism, and it is a widespread electoral strategy in Brazil (Stokes 2005; Stokes et al. 2003; Nichter 2008).

The study of clientelism is complex because, much like corruption, it is a hidden action. It is difficult to get data on the amount of clientelism going on in each locality and most studies of clientelism rely on surveys where people report having received benefits in exchange for their votes. However, these surveys are usually run in subsets of regions, and there is no country-wide dataset with which to compare clientelism outcomes at the municipality level. Due to these data constraints, some researchers have used spending on education, a good they consider as a targeted good, as a proxy of clientelistic practices because of the high discretionary power that mayors have over educational spending and the fact that is is easily targetable to individuals or smaller groups of voters (Amat and Beramendi 2020).

Another alternative is that these mayors are using the money from windfalls to engage in patronage, by hiring more people in their constituencies. Although income from royalties is not earmarked for any particular purpose, it is legally not meant to be spent on salaries for permanent employees. However, since money is a fungible good, mayors could divert resources from other areas towards paying salaries and just replace those expenditures with income from royalties. Thus,

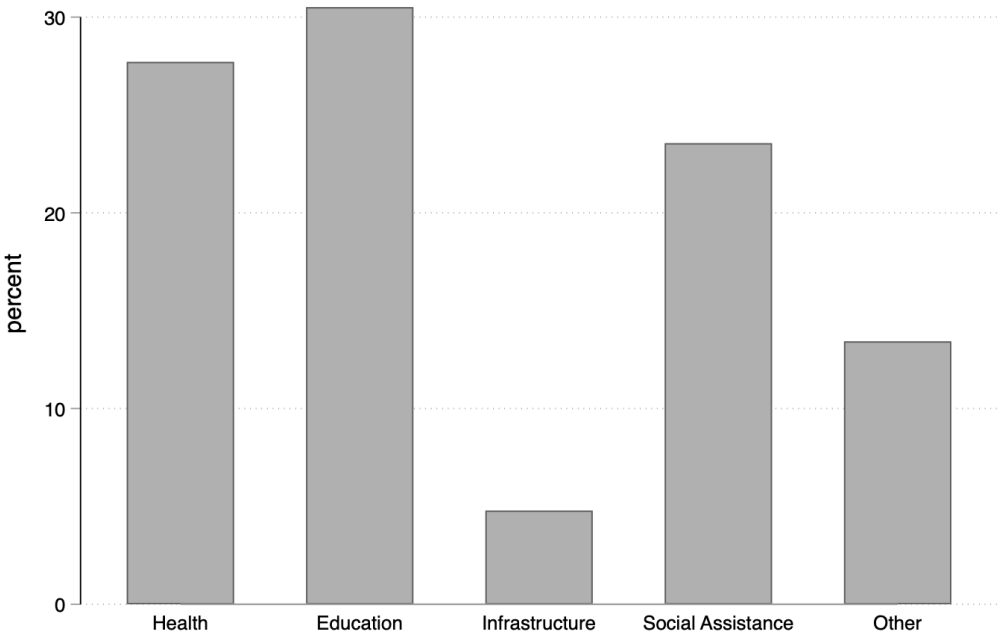


Figure 5.17: Number of Service Orders Issued in Each Area

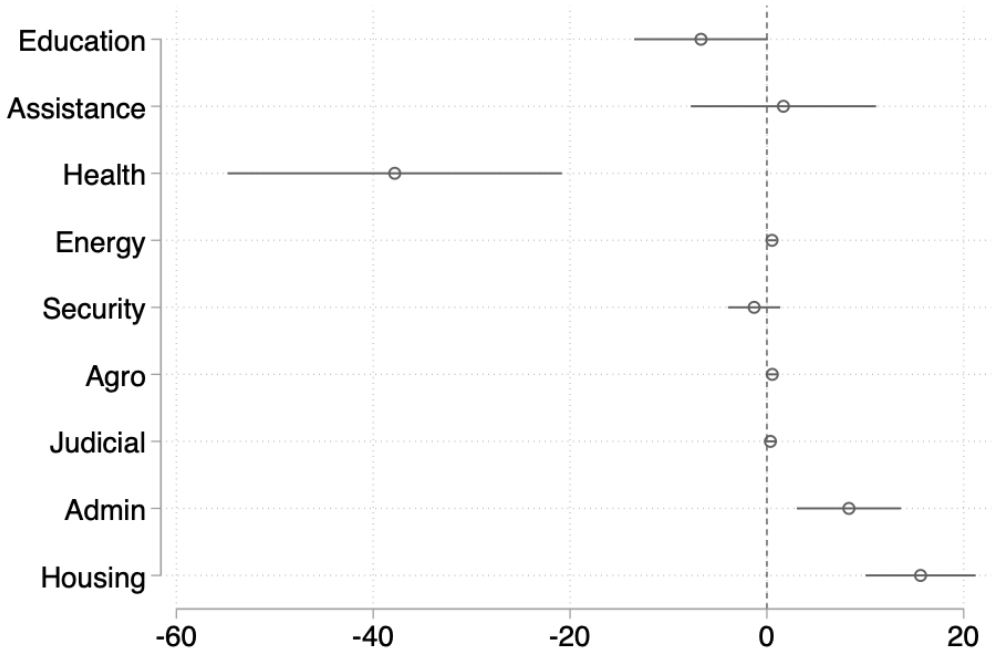


Figure 5.18: Effects of Royalties on Municipal Expenditures: Large Sample

if municipalities affected by windfalls display higher levels of administrative expenditure, the item where salaries are included in the budget, then it is likely that these places are also engaging in more

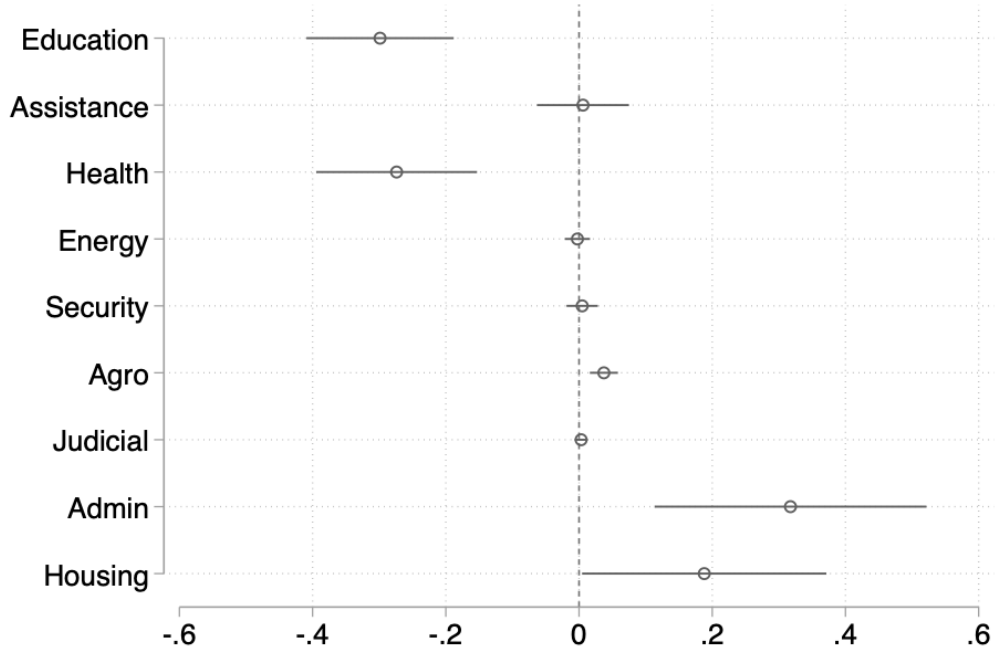


Figure 5.19: Effects of Royalties on Municipal Expenditures: Small Sample

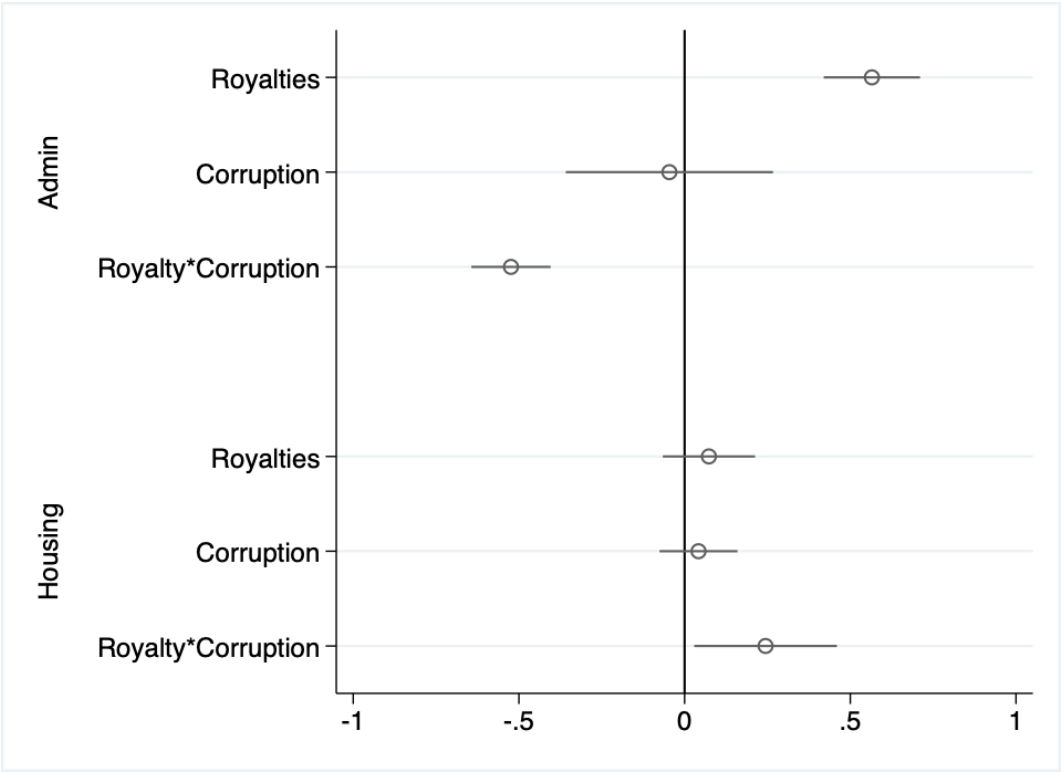


Figure 5.20: Is Corruption Driving the Spending Patterns?

patronage.

Additionally, as seen in Figure 5.17, health and education are by far the areas of spending that are most subject to audits. Municipalities spend a large share of their revenues on health and education and are, in fact, the main providers of these goods to their populations. If mayors are trying to extract funds, it may make sense to divert funds from these areas which are more subject to federal control and auditing and spend more on areas that are less likely to get audited. Finally, as has been evidenced by the recent corruption scandals and "Lavajato", construction and infrastructure projects are a main source of corruption since it is easy to fix procurement processes, over-invoice and divert funds from such large projects.

Figures 5.18 and 5.19 presents the results of regressing each of the expenditure areas on the offshore royalties variable and a set of relevant controls, as well as term and municipal/state fixed effects depending on the specification (large versus small sample). Errors are clustered at the municipal/state level depending on specification. The full regressions can be seen in Tables 10 and 11 in the Appendix. Places affected by the windfalls are comparatively spending less on education and health than those not affected. This is not a prefect measure of the effects of royalties on clientelism but it is an indication that the effect of royalties may not be going through the clientelistic channel.

On the other hand, 5.18 and 5.19 show that the effects on administrative expenditures show that municipalities that received royalties spent more on administrative expenditures, suggesting that they may have had larger payrolls. This is consistent with the patronage story. However, from Figure 5.20 we can see that most of the payroll ballooning is happening in places that did not display high corruption outcomes. In fact, places with high royalties and high corruption were actually spending less on administrative expenditures. This finding helps strengthen the claim that the cycles we observe cannot be explained purely by a clientelism or patronage story, and that these mayors are in fact enriching themselves.

The second focus of analyzing expenditures was to see if mayors in royalty receiving municipalities are spending more on activities that allow for easier embezzlement of funds. In

particular, we can see that royalty receiving municipalities spend significantly more on Housing and Urban Planning. Furthermore, 5.20 suggests that this effect is mainly driven by municipalities that are receiving royalties and also have high levels of corruption. A large proportion of Housing and Urban Planning expenditures is spent on construction projects, since it involves construction of roads, buildings and infrastructure in general. Given the explosion of corruption scandals linked to construction companies in Brazil, this is an important finding. Corrupt mayors were most likely spending the income from royalties in ways that would allow them to extract the most rent, and construction of large projects provides many opportunities for embezzlement of funds.

5.8 Discussion

The reduced form results presented in this chapter show that oil royalties have important effects on corruption and reelection rates. The results are in line with the predictions of the model. In particular, in this chapter I have provided evidence for Hypotheses 1 and 2. We see that in fact (i) royalty receiving municipalities are more corrupt on average than non royalty receivers, (ii) corruption is higher for second term mayors, (iii) corruption is higher after a boom election and lower after a bust election in royalty receiving municipalities and (iv) reelection rates are higher during a boom election and lower during a bust election in royalty receiving municipalities, compared to non royalty receiving municipalities. These reduced form results are robust to different model specifications, mostly robust to entropy balancing and inverse probability weighting and also hold up to an instrumental variables approach where the international price of oil is used as an instrument for oil royalties.

Furthermore, we see that alternative explanations linked to informational channels do not hold up in this context, suggesting that it is in fact a moral hazard and adverse selection story. In the following chapter I show that the selection into politics story (endogenous entry) is also a channel that helps explain the body of empirical evidence I find in the Brazilian case.

Finally, the results show that oil royalties have important downstream effects on the way

municipalities allocate their budgets. Oil affected municipalities spend significantly more on construction, infrastructure and housing investments as well as on administrative expenditures which usually correspond to salaries, suggesting that oil royalties are used in corruption prone expenditures and as a form of patronage. Additionally, they spend significantly less on health and education, where they are more likely to get audited. This distortion in the allocation of public spending may help explain why oil affected municipalities have failed to raise the living standards of their citizens, despite the large inflows of cash into their coffers.

6 Recovering the Effects of Oil Royalties on Entry and Pooling

One of the novel mechanisms identified by the theory has to do with the deterioration of the quality of candidates in oil affected municipalities during booms. How can we know if the quality of candidates who enter into politics really deteriorates during oil booms? The quality of candidates is by definition an unobserved trait, and furthermore, it is confounded by both a candidate's decision to pool and the voter's decision to reelect or not. This means that reduced form techniques are not well suited to estimate such a parameter.

In this chapter, I use a calibration exercise in order to identify these unobserved parameters, and also run some counterfactual exercises. Although calibration is not a common technique in Political Science, it has been widely used in economics, both in macro-economics and in general equilibrium micro-economic models (Cooley 1997; Dawkins et al. 2001; Vanni et al. 2011; DellaVigna 2018; Kydland and Prescott 1982; DeJong and Dave 2011; Galiani and Pantano 2021)[1] . Calibration is very useful for estimating uncertain or unknown parameters by comparing model outputs to empirical data, thus enabling the researcher to identify the model parameter values that achieve a good fit of the theoretical model to the real world, observed data.

As stated by Dawkins et al. (2001): "*Calibration of an economic model involves the setting of specified parameters to replicate a benchmark data set as a model solution. Once calibrated, the model can be used to assess the effects of an unobservable or counterfactual change in policies*

[1]For an in depth review of how these and structural models have been used in empirical microeconomics, with a focus on labor economics, the reader is referred to Galiani and Pantano (2021).

or other parameters: a change in a tax rate, the removal of a quota, or changes in the values of parameters exogenous to the model such as the prices of traded goods in a model of a small, open economy." Here, the intended parameters of interest are the quality in the pool of candidates and the decisions of incumbents to pool or not. However, we could test what would happen in our model economy if we were to hold an election during a boom or a bust, as well counterfactual policies such as what would happen to corruption and reelection rates if we were to implement alternative royalty distribution rules, such as those which have been proposed in the Brazilian congress.

The final hypothesis derived from the model presented in Chapter 3 is about the deterioration of the quality of the candidate pool in the presence of oil booms. In the following sections I first present suggestive evidence that oil windfalls lead to the entry of more venal types into politics, and then present the results of the calibration exercise which allow me to recover the unobserved parameters.

6.1 Suggestive Evidence on Endogenous Entry

The final hypothesis derived from the model has to do with the quality of the candidate pool. Figures 6.1 and 6.2 provide some suggestive evidence that there could be something like the predictions of the model happening in royalty receiving municipalities. We can see in Figure 6.1 that the number of candidates is much larger in royalty receiving municipalities as compared to non royalty receiving municipalities and varies quite a bit by elections. These effects are robust to controlling for income and population size. Additionally, we can see that the size of the candidate pool follows the international price of oil quite closely, growing until 2008 and falling in 2012. The results do not look the same if instead of testing the difference between royalty and non royalty receivers we test by size of federal transfers (Figure 6.2), implying that this is not just driven by a purely "more money, more candidates" phenomenon.

I further test whether education could be used as a proxy for quality. In my model, quality has to do with a candidates' willingness to engage in corruption. A priori, I don't expect that

education can serve as a proxy for this since higher levels of education do not necessarily imply more honesty. In fact, much of the corruption in the higher government levels is carried out by highly educated politicians.

Following Carnes and Lupu (2016), I use close elections, i.e. places where the winner's margin of victory was less than 5 percentage points, to compare places where a college educated candidate barely won to places where a non college educated candidate barely won. This allows me to identify the effects of holding a university degree on the level of corruption. Like Carnes and Lupu (2016), I find no difference on the overall levels of corruption for college educated mayors. However, once we break it down into oil receiving versus non oil receiving municipalities, some interesting patterns emerge. Figure 15 shows that corruption appears to be higher in oil receiving municipalities when the mayor holds a college degree. In fact, the difference in corruption outcomes between oil and non oil municipalities increases for closely elected mayors with college degrees.

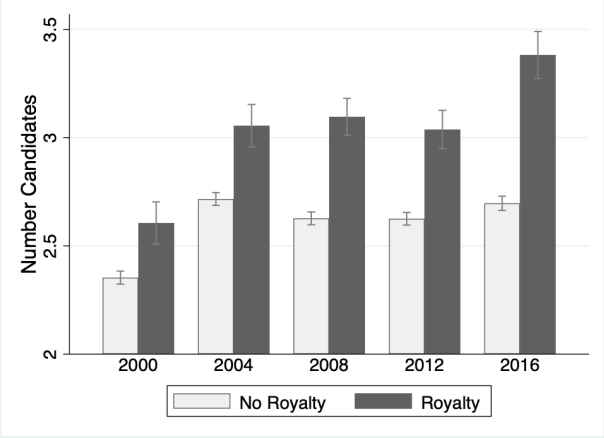


Figure 6.1: Number of Candidates: Oil

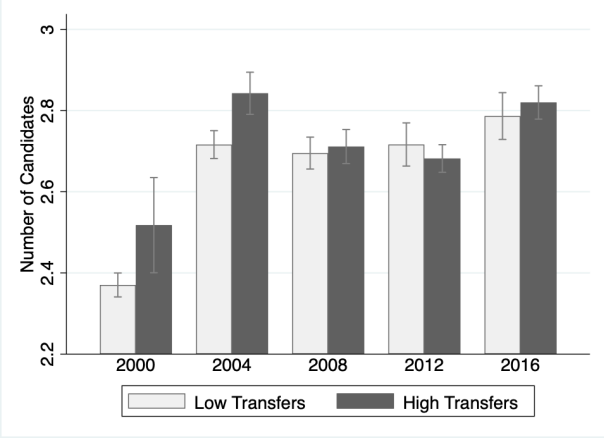


Figure 6.2: Number of Candidates: Transfers

Figure 6.3 shows the effects of royalties on a set of different dependent variables which might describe the pool of candidates. Royalties have a positive effect on the number of candidates, a 10% increase in royalties leads to a 0.1 increase in the number of candidates. Considering that the mean number of candidates is about 2.8, this can be considered a sizable effect. Royalties have a small and insignificant effect on the proportion of female candidates in the incoming pool of candidates, and a negative effect on the proportion of candidates with college and high-school

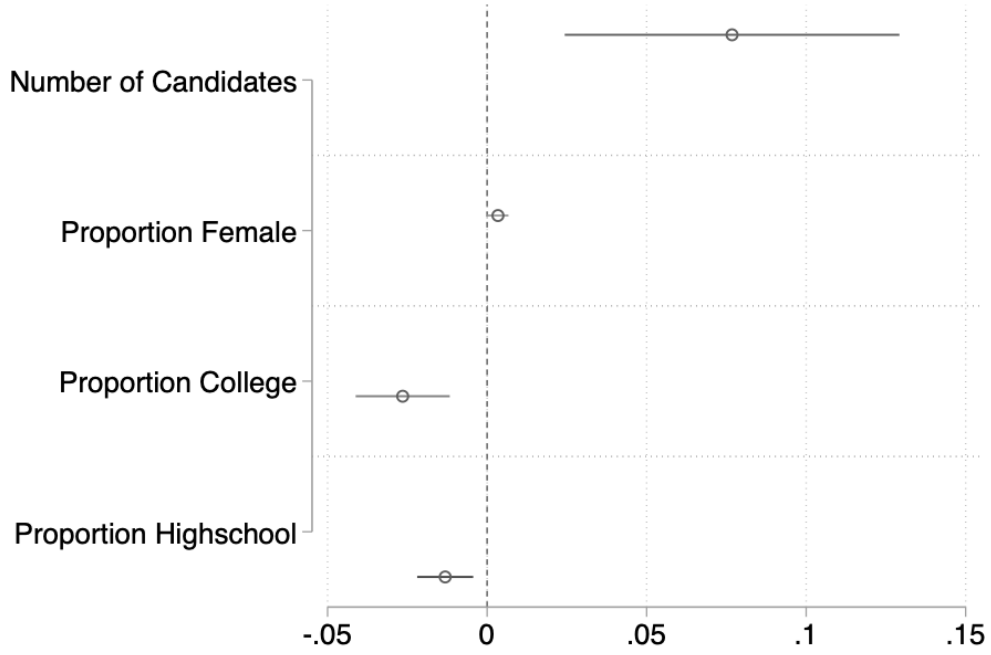


Figure 6.3: Effects of Royalties on Entry of Candidates

education.

Although there is some evidence that oil royalties lead to more candidates entering the race (see Figures 6.1-6.3 in the Appendix), it is difficult to test this with reduced form regressions. The results are suggestive that the predicted effects may be taking place, however it is unclear whether these observable variables such as educational attainment or gender correlate well with a candidates' honesty. In the literature, there is some evidence that women are less corrupt than men (Alexander et al. 2019; Dollar et al. 2001; Esarey and Chirillo 2013; Esarey and Schwindt-Bayer 2019), but in Brazil it is unclear whether more educated candidates are less corrupt than their less educated counterparts, and in fact there is work by Carnes and Lupu (2016) proving that this is not the case.

6.2 Calibration Exercise

To estimate the role of hidden actions (moral hazard) and hidden types (adverse selection and entry into politics), I use the structure of the model and simulated data. Since candidate type

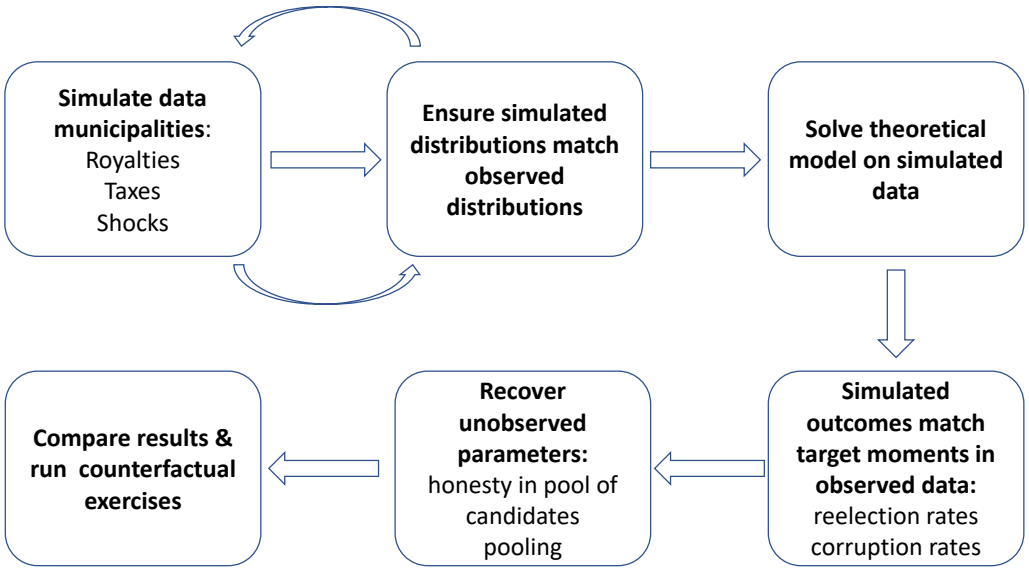


Figure 6.4: Calibration Flow Chart

and pooling decisions are unobserved in the data, I solve the model on simulated data where types are drawn from a known distribution and use this to recover latent moments for candidate type, whether incumbents are pooling or not and the average type of the pool of candidates.

Figure 6.4 shows the steps involved in this calibration exercise. First, I simulate data that resembles the observed data for our real world municipalities. I use observed moments such as the mean and standard deviation of royalties, and the mean and standard deviation of taxes[2] Given that this is an iterative process, these two squares represent what I describe below in Step 1. Once the simulated data matches the observed data closely, I can solve the theoretical model using the equations and equilibrium derived in Chapter 3, this is described below in Step 2. This will then lead to some outcomes such as reelection rates and corruption rates which will flow from the model. If the simulated outcomes match the observed target moments (reelection rates and corruption rates) well, then the model is doing a good job at capturing the dynamics which are leading to these

[2]More moments can be used in order to better match the simulations to the observed data. An alternative approach is to randomly select real municipality observations, much like a bootstrapping method. Future work will focus on improving this by utilizing both of these methods.

real world outcomes. This is described in Step 3. We can thus use the solved model to recover unobserved parameters and run counterfactual exercises, which is described in Step 4.

6.2.1 Step 1: Data Simulation

The first step in the calibration process is to simulate data that closely resembles the real world, observed data. I simulate data for a set of 1,000 municipalities where oil royalties and income from taxes are drawn from distributions which have been fitted to the data. The oil royalties and income from taxes were fit to several different distributions which resembled their Cumulative Distribution Functions (CDFs). The best fit was achieved by Negative Binomials for both oil royalties and income from taxes as can be seen in Figure 6.5-6.7. Using these fitted distributions, I then draw 1,000 random samples from these distributions to create a panel of municipalities with oil and income distributions that match the observed data.

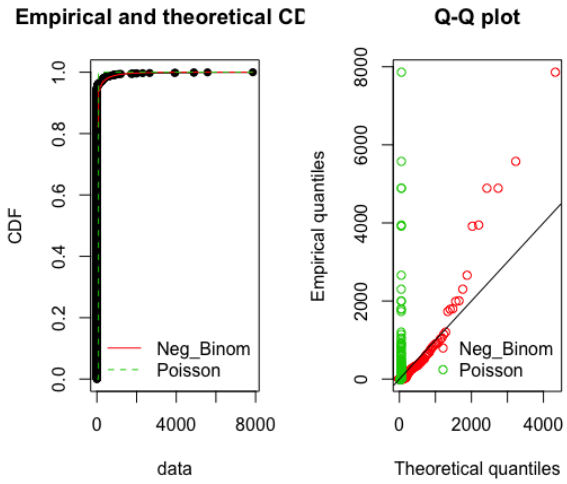


Figure 6.5: Fitted Values Oil Revenues

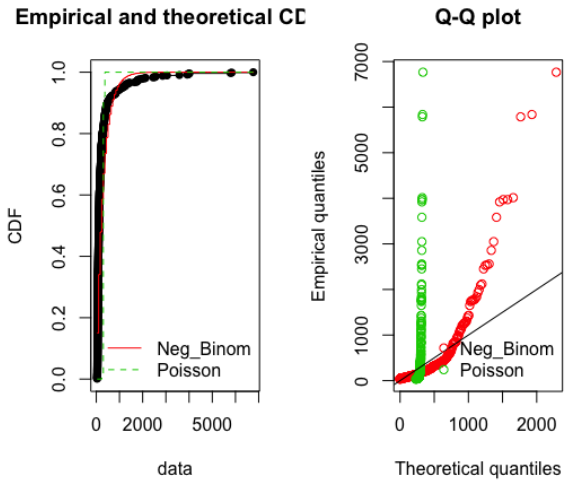


Figure 6.6: Fitted Values Tax Revenue

The parameters used in the calibration of the model can be seen in Table 6.1. Panel A shows the parameters used in the fitted distributions for oil royalties, Ω_1 in the model, and income from taxes, x_1 in the model. The fitted mean of the negative binomial was 3.7 for oil royalties, μ_o, and 300.81 for tax income, μ_x, while the dispersion parameter was 0.0019 for oil royalties, $size_o$, and 0.5 for tax income $size_x$. Given that no municipalities in our sample have 0 tax income, but many

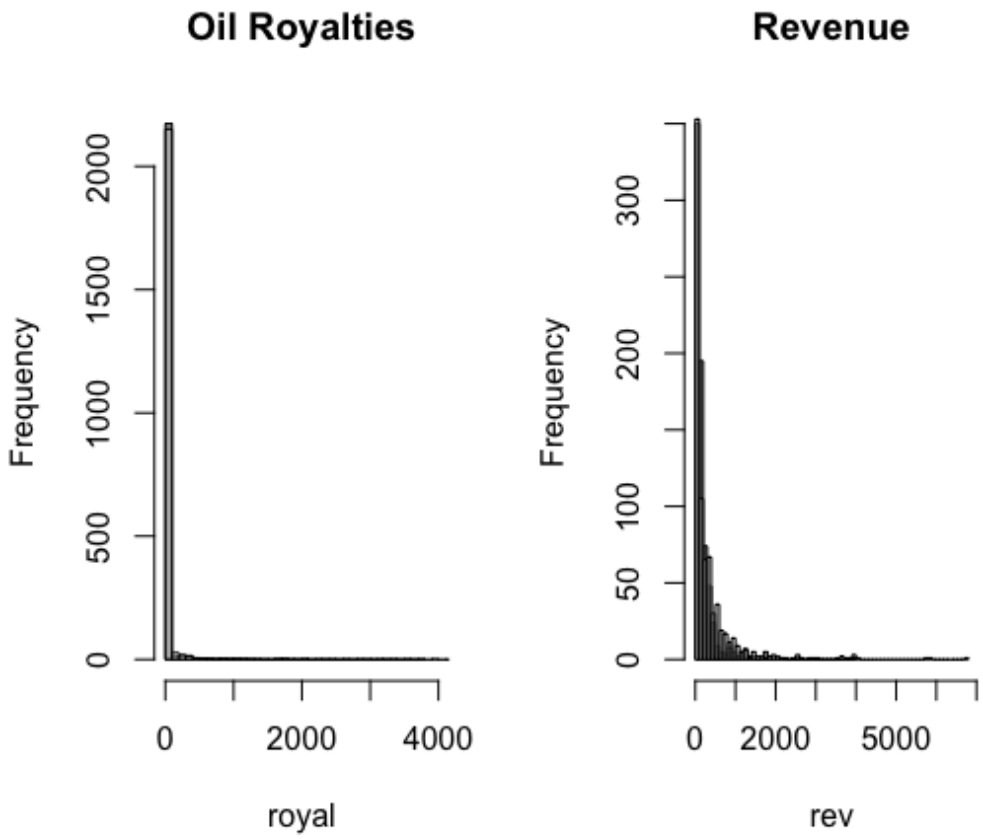


Figure 6.7: Histograms of Fitted vs Observed Data

have very small income from taxes, when $x = 0$, I set it to $x = 1$.

Panel B shows other model parameters which have been chosen to calibrate the model. I set the discount factor to $\beta = 0.6561$, which represents an annual discount factor of 0.9, the probability of being in a good state, meaning that the cost shock is low, to $q = 0.7$, so that there is a 70% chance of being in a good state, where the cost shock is low and bad types can't pool, and a 30% chance of being in a bad state, where the cost shock is high and bad types can pool and pretend to be good types. The cost shocks in the good state, θ_L is normalized to 1, while the cost shock in a bad state, θ_H is set to 1.1, which means that in a bad state, providing the same public good will be 10% more expensive than in the good state. The initial proportion of honest incumbents, π_1, from which office holders in t=1 are drawn from is set to 0.5.

For a boom period, growth rate in taxes, Δ_x is set to 10%, which represents an annual growth rate of 2.4%, consistent with growth in Brazil during the studied period. I simulate the model for boom periods and bust periods separately. For boom periods, the growth rate for oil royalties between period 1 and 2, Δ_o is set to 70%, which represents an annual growth rate of about 14%, consistent with the data on oil royalties for the period. For boom periods, the growth rate, Δ_o , is set to -0.5, representing a contraction of royalties.

The outside wage option is set to 70 for honest types, W_g, and 100 for dishonest types, W_b. This represents the fact that dishonest types may be capable of extracting rents in other jobs as well as in office, or it also could represent that in general they are more highly skilled. Results are somewhat robust to setting both to 70, but the moment conditions match better with these values. If anything, this decision biases against the entry effect into politics, since bad types have a higher outside wage and therefore have a higher opportunity cost of entering into politics. Finally, the proportion of honest citizens who would be able to enter politics if they decided to, α, is set to 50%, and the ego rents from holding office, R, are set to 200.

Table 6.1: Model Calibration

Parameter	Value	Interpretation
Panel A: Simulated from fitted distributions		
Ω_1	$\backsim NB(mu_o, size_o)$	Distribution of oil royalties
mu_o	3.7	Mean of royalties distribution
$size_o$	0.0019	Dispersion parameter for royalties distribution
x_1	$\backsim NB(mu_x, size_x)$	Distribution of taxes
mu_x	300.81	Mean of taxes distribution
$size_x$	0.5	Dispersion parameter for taxes distribution
ε	$N(\mu_\varepsilon, \sigma_\varepsilon)$	Random error in perception of Public Goods
μ_ε	0	Mean of the error
σ_ε	10	Standard Deviation of error
Panel B: Calibrated model parameters		
β	0.6561	Discount factor
q	0.7	Probability of being in a good state
θ_L	1	Good state cost shock
θ_H	1.1	Bad state cost shock
π_1	0.5	Proportion of honest incumbents t=1
W_g	70	Outside wages for honest type
W_b	100	Outside wages for dishonest type
α	0.5	Proportion honest citizens
R	200	Ego rents from holding office
$\bar{s}$	0.3	Maximum % of corruption
Δ_x	0.1	Taxes growth rate
Δ_o^1	0.7	Oil growth rate: Booms
Δ_o^2	-0.5	Oil growth rate: Bust
N	1,000	Number of municipalities in each simulation

Table 6.2: Moments - Simulated versus Observed Data

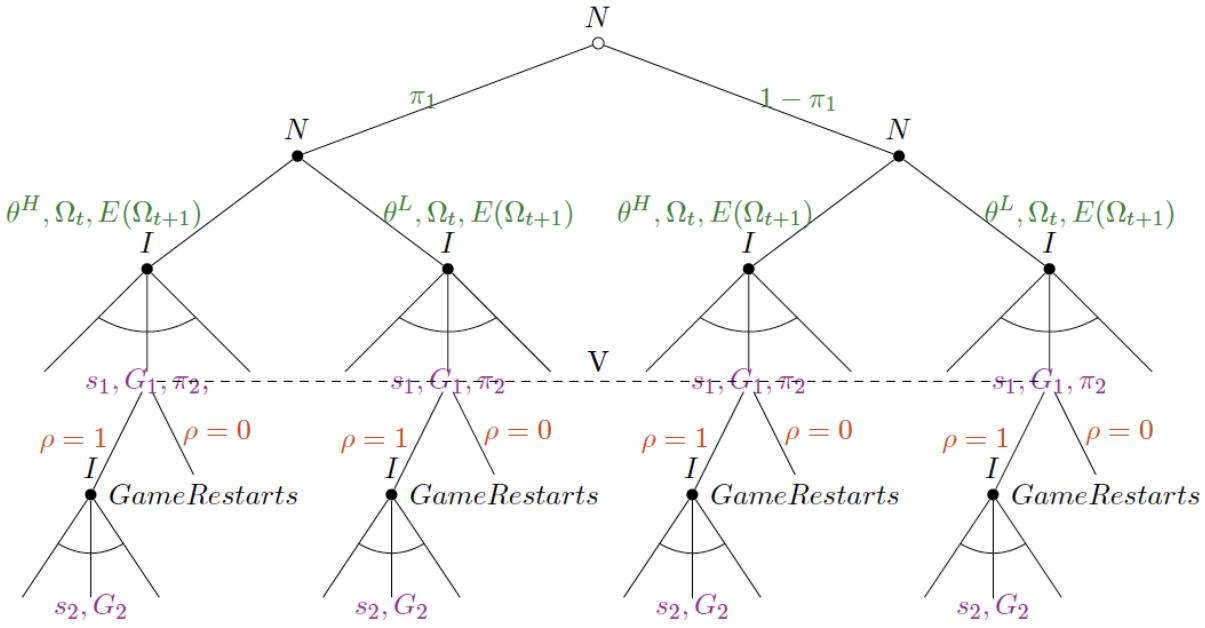
Moment	Simulated	Observed
Panel A: General Moments		
Mean Royalties (Ω)	3.72	3.43
Standard Deviation Royalties	32.26	31.00
Mean Taxes (x)	282.78	279.75
Standard Deviation Taxes	596.73	600.31

6.2.2 Step 2: Solving the Theoretical Model

Once a panel of simulated municipalities which resembles the observed data is created, I solve the theoretical model on this data. Figure 6.8 shows the extended game which is solved. Here, green parameters are simulated in Step 1, while purple and red parameters are obtained from the solution of the game theoretic model. The purple parameters represent outcomes which depend directly on politician behavior, while the red represent outcomes which depend directly on voter behavior. Of course, due to the strategic nature of the game, these are interrelated and jointly determined. From equations 3.1- 3.5 and the utility functions of voters, citizens considering running for office and incumbent politicians, I obtain the conditions for the different solutions presented in Table 3.2. Given that in the simulated data we know the unobserved values for politician type and also the random shocks which have been drawn from the distributions outlaid in Table 6.1, I am able to fully solve the model and obtain numerical values for our outcomes of interest. In this case, in order to see whether the model is properly calibrated and captures the dynamics I am after, I look at the reelection and corruption rates in oil versus non oil municipalities during booms and busts.

6.2.3 Step 3: Comparing Simulated Outcomes to Observed Outcomes

The calibration of the model is targeted to the moments presented in Table 6.3. Here, we see that the simulated data from the model on the left column is very similar to the observed data on the right. Importantly, the model is able to capture the observed differences in reelection rates and corruption outcomes between oil and non oil municipalities during booms and busts. Essentially, the model is able to reproduce the reduced form estimates derived from Hypotheses 1 and 2 which we identified in Chapter 5. Although the model slightly over-estimates the difference in reelection rates and corruption between oil and non oil municipalities, it does a very good job of capturing the averages and also the differences between them. The moments shown here also reflect the reduced form effects found in the regression results presented in the previous chapter where we show that oil windfalls have a positive effect on corruption after boom elections and a negative effect after



Legend					
π_1	Pr(Honest)	Ω_t	Current Oil Windfalls	G_t	Gov. Expenditure in t
θ^L	Low Cost Shock	$E(\Omega_{t+1})$	Expected Oil Windfalls	π_2	Average honesty in pool
θ^H	High Cost Shock	s_t	Corruption in t	ρ	Reelection $\in \{0, 1\}$

Figure 6.8: Solving the Theoretical Model

Table 6.3: Equilibrium Moments - Simulated vs Observed Data

Moment	Simulated	Observed
Panel B: Boom Periods		
Mean Reelection Rates (σ): oil municipalities	0.38	0.35
Mean Reelection Rates(σ): non oil municipalities	0.26	0.26
Mean Corruption (s): oil municipalities	24.89	22.57
Mean Corruption (s): non oil municipalities	20.81	20.16
Panel C: Bust Period		
Mean Reelection Rates (σ): oil municipalities	0.35	0.33
Mean Reelection Rates(σ): non oil municipalities	0.40	0.39
Mean Corruption (s): oil municipalities	17.56	18.33
Mean Corruption (s): non oil municipalities	21.05	20.76

bust elections, as well as the positive effect on reelection rates during boom elections and negative effect during bust elections. Essentially, this modeling exercise is able to reproduce the reduced form findings, and thus allows us to explore the mechanisms through which these are arising inside our theoretical model.

6.2.4 Step 4: Recovering Unobserved Parameters

Using the simulated data, I then recover the following latent moments of interest: (1) which incumbents are honest and which are dishonest (hidden type), (2) which incumbents are pooling (dishonest types pretending to be good types in order to get reelected), which represents the hidden action (moral hazard) effect, and (3) the average honesty of the pool of candidates, which represents the entry effect (hidden type). The results are presented in Table 6.4, disaggregated by whether a municipality is an oil royalty receiver or not and whether we are looking at a boom or a bust period. Recall from Chapters 2 and 3 that we expected higher entry of dishonest types into politics in oil royalty receiving municipalities during booms, since these types of citizens are drawn to future rent extraction perspectives. Analogously, we expected a lower proportion of dishonest types entering into politics during busts since these periods represent lower rent extraction expectations, and thus lead to fewer dishonest citizens deciding to run for office.

From the calibration we can see that during booms, oil municipalities had slightly more

Table 6.4: Recovered Latent Moments

Latent Moment	Oil Municipality	Non Oil Municipality
Panel A: Booms		
Proportion Dishonest Incumbents	0.51	0.47
	[0.47 , 0.55]	*[0.44 , 0.51]*
Proportion Incumbents Pooling	0.30	0.23
	[0.27 , 0.34]	*[0.20 , 0.26]*
Proportion Dishonest in Candidate Pool	0.63	0.51
	[0.62 , 0.64]	*[0.50 , 0.53]*
Panel A: Busts		
Proportion Dishonest Incumbents	0.46	0.49
	[0.43 , 0.50]	*[0.46 , 0.52]*
Proportion Incumbents Pooling	0.05	0.21
	[0.01 , 0.09]	*[0.18 , 0.25]*
Proportion Dishonest in Candidate Pool	0.33	0.52
	[0.28 , 0.38]	*[0.51 , 0.53]*

95% confidence intervals presented in square brackets

dishonest incumbents to begin with, with 51% of the incumbents being categorized as dishonest in oil municipalities and 47% in non oil municipalities, although these differences are not statistically significant. In other words, we can consider these municipalities as starting from the same point, each having about half of their incumbents as dishonest typed to begin with. Figures 6.9 and 6.10 show the recovered latent moments from the simulation. In both figures, blue estimates correspond to bust periods, while red estimates correspond to boom periods. We can thus compare the recovered latent moments for boom versus bust periods for oil and non oil municipalities.

Figure 6.9 shows that during booms about a third of the dishonest incumbents pool in oil municipalities, while only 23% of incumbents pool in non oil municipalities. The differences between boom and bust period pooling are statistically significant at the 95% confidence interval. This result is driven by the fact that during a boom period, future oil revenue creates incentives for dishonest candidates to pretend to be honest by stealing less in period 1, so they may get reelected and then steal more in period 2. During a boom, the large expected revenues also generate incentives for more dishonest candidates to enter into politics, which is reflected in the 63% of dishonest candidates in oil municipalities as shown in Figure 6.10. We see no disproportionate effects of booms/busts on entry of dishonest types in non oil municipalities, where rents are stable. This is

what we would expect to see, and is a result that gives credibility to this exercise, since non oil municipalities should not be affected by boom vs busts because their municipal budgets do not fluctuate according to these categories. Importantly, during booms the entry of these candidates means that $\gamma > \pi_2$[3], so voters will always reelect the incumbent when she is a good type and when she is a dishonest type pooling. Only dishonest types who reveal their type by stealing everything they can in the first period are voted out during booms.

During busts, the dynamics reverse. Since expected rents drop significantly in oil municipalities, hardly any incumbents have incentives to pool, in fact only 5% choose to do so, as shown in Figure 6.9. Additionally, the drop in expected rents in period 2 leads to fewer dishonest candidates entering into the pool in oil municipalities, which further decreases incentives to pool given that voters have even less incentive to reelect incumbents when they are not sure they are good types, because of the improvement in the pool of candidates. On average, the pool of candidates in oil municipalities during a bust election contains only 33% of dishonest incumbents as shown in Figure 6.10, which means that if the voter is faced with uncertainty over the incumbent's type, he is better off choosing a random candidate from the pool. Again, the values for non-oil municipalities remain quite stable since there are no large fluctuations in the revenues, thus the distortions created by the royalties do not exist here.

[3]Note that the proportion of dishonest candidates in the pool presented in Table 6.4 corresponds to $1-\pi_2$, since π_2 represents the expected proportion of honest candidates in the pool.

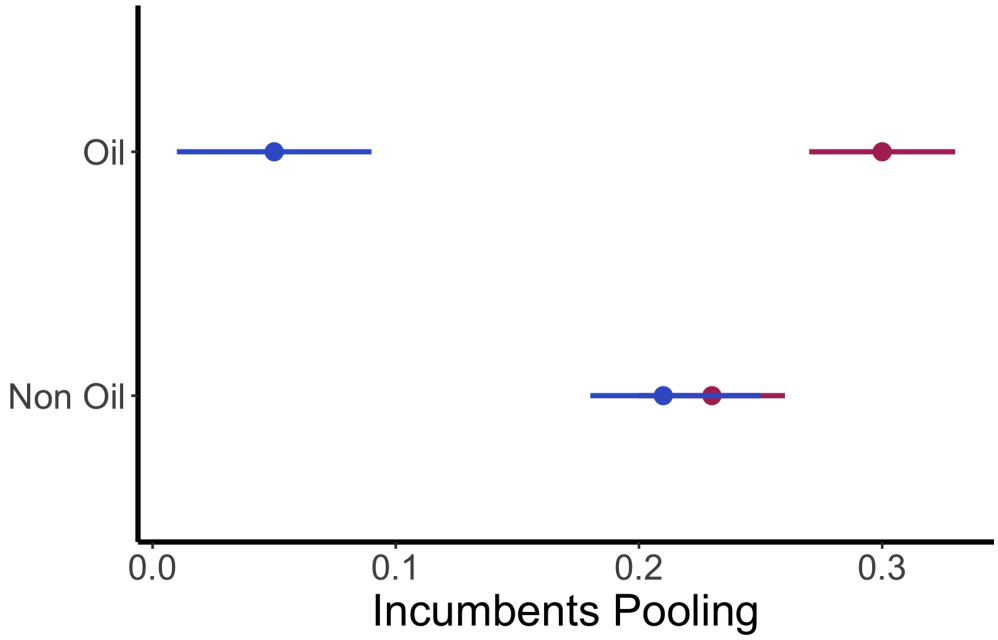


Figure 6.9: Recovered Latent Moments - Pooling During Booms and Busts

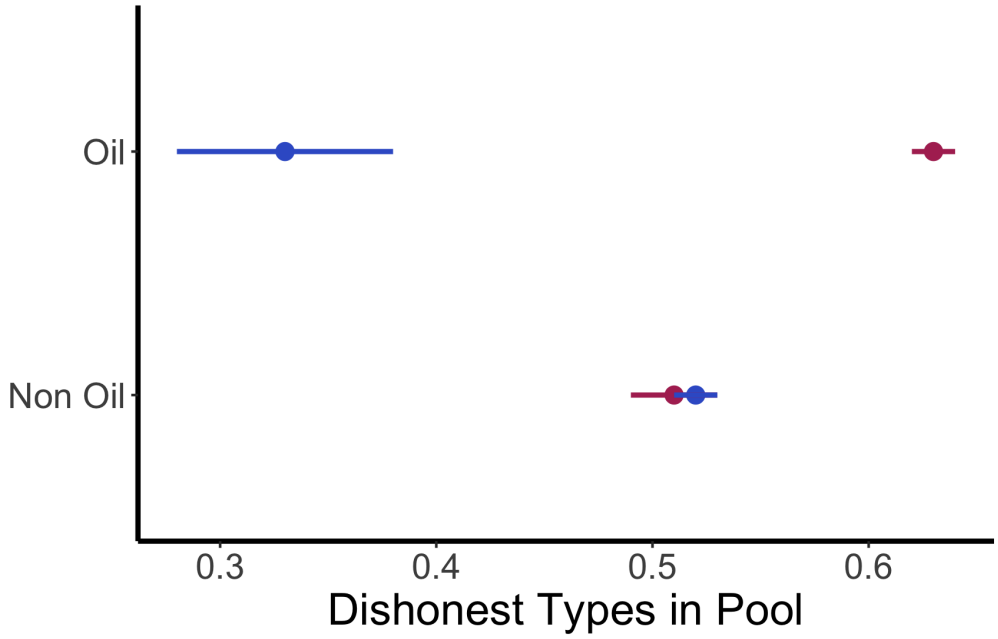


Figure 6.10: Recovered Latent Moments - Dishonest Candidates During Booms and Busts

6.3 Decomposing the Effects of Oil Windfalls on Corruption

In order to understand what mechanisms are driving the results, I decompose the effects of oil windfalls on corruption by looking at three distinct channels: electoral discipline, selection and entry of types into politics. The effect of entry into politics is constructed by comparing the predicted corruption outcomes if the model had no entry to the full model presented above. In other words, using the benchmark model presented in section 3.1, where $\pi_1 = \pi_2$ and we do not allow for π_2 to vary endogenously based on citizens decisions to enter into politics. The effects endogenous entry are thus represented as the added pernicious effects that a one standard deviation increase in oil windfalls have on corruption levels once we allow for endogenous entry.

The effects of selection and electoral discipline are computed in a similar way, following (Avis et al. 2018). First, I estimate the predicted corruption outcomes in the model as if there were no windfalls, so setting $\Omega_i = 0$ for all municipalities. The effect of selection is estimated by comparing the predicted corruption outcomes for second term mayors in the original model with windfalls to that of second term mayors without windfalls, where there is no electoral discipline in place because they cannot be reelected. Thus, the effects of windfalls on corruption outcomes for second term mayors are driven by the fact that windfalls have made it more difficult to select good types, thus identifying the selection effect.

The electoral discipline channel is then recovered as the comparison of predicted first term

Table 6.5: Increase in Corruption due to Oil Windfalls

	Difference in Corruption	Percentage of Effect
Electoral Discipline	0.8	21.6%
	[0.23]	
Selection	1.3	35.1%
	[0.34]	
Entry	1.6	43.2%
	[0.13]	
Total	**3.7**	**100%**
	[0.28]	

Standard errors computed using the Delta Method in square brackets

rents under the $\Omega_i = 0$ condition compared to the original rents predicted in my calibration model.

Table 6.5 shows the results of this decomposition exercise. We can see here that the total effect of a one standard deviation increase in oil windfalls on corruption is 3.7% (meaning that on average a one standard deviation increase in oil windfalls will lead to an increase by 3.7 percentage points in the predicted corruption rate). Of this total 3.7%, 0.8% is caused by the electoral discipline which corresponds to 21.6 percent of the total effect. The selection mechanism accounts for about 1.3% of the the 3.7%, which corresponds to 35.1 percent and the entry effect accounts for about 1.6% of the effect, which corresponds to about 43.2 percent of the total effect of oil windfalls on corruption.

The results in this section are interesting when considering the effects that introducing politician types have on the effectiveness of electoral discipline to keep politicians accountable (Besley 2006). In fact, in this model with different politician types, the effects of selection are significantly larger than those of electoral discipline. This is exacerbated once we allow for endogenous entry, where the types of the people in the pool of challengers also become an issue that affects voter's decision making.

6.4 Discussion

The exercises presented in this chapter help to illustrate and quantify the effects of oil royalties and the fluctuations of these income sources on the political outcomes of interest. Through the model calibration, I am able to show the effects of royalties on pooling (hidden action) and endogenous entry (hidden type), both of which are unobserved. Together, these dynamics lead to the corruption and reelection cycles we observe in the data. During booms, more dishonest incumbents pool in an effort to gain reelection, more dishonest candidates enter into politics in an effort to access future rents and therefore more dishonest incumbents get reelected into office. These mechanisms lead to higher corruption in oil municipalities, especially for second term mayors. During busts, incumbents have less incentive to pool and therefore steal more in their first term. The

improvement in the quality of the pool of candidates in oil municipalities means that incumbents are more likely to get voted out, and honest candidates are more likely to be selected from the pool, which leads to lower corruption in the period following a bust election.

The results presented in this chapter allow me to pinpoint the exact mechanisms that are leading to the observed outcomes within the simple framework, shedding some light on how these dynamics may be playing out in the real world. Recovering latent parameters from models and observed behavior has been widely used in ideology estimates (Poole 1985; Poole and Rosenthal 1991) within Political Science, but has not been as widely used in political economy models where we can use them to test for counterfactuals, and also engage in thorough welfare analysis.

The implications of this exercise are important not only for our understanding of the sources of the corrupting effects of oil windfalls on politics, but also as a way to understand what are the possible policy solutions to this issue and their welfare effects. For example, if a policy maker were to focus only on the selection effect, attempting to provide information to voters on the incumbent's honesty, then he will only be targeting about 20% of the problems generated by windfalls, and will be missing about 60% of the total effect. Once we establish that the cycles of windfalls play a large role in both the selection and the entry of more venal types into politics, it becomes clear that a policy insulating government budgets from the windfalls, rather than an informational campaign, will be more effective at curbing the negative effects of these resource windfalls on political outcomes. In this sense, the calibration exercise presented in this section provides us with a distinct opportunity to estimate different effects of alternative policies on reelection rates, corruption rates and citizen welfare, while also providing a clear identification of the distributive consequences of different policies which may take away resources from oil rich municipalities to distribute to the rest of the country.

Finally, in this chapter I show that if we don't consider the entry effects driven by windfalls, we might actually miss more than 40 percent of the effects. The effects windfalls have on shaping the political class are important and substantial in size, especially during a period of mostly successive boom elections like we observed between 2000 and 2016, where we can see the political class

significantly deteriorate. This deterioration of the political class can lead to important setbacks for the proper functioning of democracy. In Latin America, we have seen rising distrust in the political class (IDB-LAPOP 2016-2017), falling support for democracy, disenchantment with the political system and a rise in populist outsiders and political turmoil in countries as diverse as Brazil with Bolsonaro, Peru with the recent dissolution of parliament and possible election of authoritarian populist Castillo and Chile, with the rise in support for characters such as Pamela Jiles and Jose Antonio Kast, all of which are strongly affected by the recent commodity boom. Although there may be many other forces leading to this large scale outcomes, putting an emphasis on the role that commodity windfalls can have on the quality of the political class could be a key topic to consider when thinking about the detrimental political effects of the resource curse.

7 Conclusion

In this dissertation, I develop and test a theory for how oil windfalls affect political accountability by changing the electoral dynamics and leading to corruption. Oil royalties provide a substantial and volatile inflow of non tax-payer money to municipal coffers, creating dynamic incentives for politicians in office. As such, I argued that resource windfalls change politicians' budget constraints, generate difficulties for voters to distinguish politicians' integrity, and create incentives for corruptible candidates to enter politics, changing the pool of candidates that voters can use to replace incumbents. Oil, thus, affects corruption outcomes through three distinct channels: (i) ex ante selection: oil shocks affect the type of politician who decides to run for office; (ii) moral hazard or electoral discipline: oil shocks affect the incentives politicians have while in office; and (iii) ex post selection: oil shocks can affect the capacity of voters to evaluate politician type and successfully select honest politicians.

In Brazil, where offshore royalties are determined and allocated exogenously, oil inflows create strong opportunities for corruption. I find that a one standard deviation increase in oil royalties produces about a 29% increase in the percentage of funds being used in corrupt ways. This is an important finding, especially considering that municipalities which face new offshore oil fields are constantly exposed to shocks of this magnitude. I also provide evidence that oil has a cyclical effect on corruption. The level of corruption is lower after a fall in the price of oil, and a negative forecast for the future price of oil, while it is higher after a rise in the price of oil and a positive forecast for future oil prices. In addition, oil royalties lead to a reelection cycle: when the price of oil is expected to be higher, incumbents are reelected more often than when the price of oil is

expected to fall. This is independent of economic effects such as changes in GDP, indicating that economic voting is not the explanation for these cycles. What this reflects is that during booms, more dishonest incumbents get reelected into office due to a combination of them pretending to be honest types in the first term (pooling), and due to the entry of more dishonest types into the pool of candidates which deteriorates the pool and makes voters less likely to replace an incumbent with an unknown challenger.

Further, I show that royalty receiving municipalities spend differently than their non royalty receiving counterparts. Spending patterns suggest that the corruption cycles are not confounded by clientelism and patronage, and that in fact, corrupt mayors in royalty receiving municipalities spend much more on areas where corruption is widespread and easy to undertake such as housing and infrastructure investments, and spend significantly less on areas that are more closely monitored by the auditing agency like health and education. These diverging spending patterns as well as the diversion of funds could also be leading to the slow increases in well being for citizens living in these revenue rich, oil affected municipalities. Future work looking at possible spillover effects of these spending patterns on the number and types of jobs, as well as the quality of health and education services inside these municipalities could shed further light on the general equilibrium effect of the windfalls. If the spending patterns further distort job markets in a negative way, for example creating low paid, low quality jobs, rather than creating high paying jobs, then this could be a further avenue through which windfalls can affect local level socio-economic outcomes.

Finally, using a calibration exercise on simulated data which matches the moments observed in the data, I recover latent moments like incumbent type, pooling decisions and the average honesty of the pool of candidates, which allows me to show how the model's mechanisms play out in the data. The entry of dishonest candidates drives the cycles observed in oil municipalities. Through this entry mechanism, I show that the effects of oil windfalls on the quality of the political class are a novel way through which oil windfalls hamper the functioning of democracy. In fact, about 40 percent of the effect of oil windfalls on corruption is produced by the entry of more dishonest types into the pool of candidates. These results are important and suggest that policies which ignore the

effects of the windfalls on the entry of dishonest candidates will likely be unable to solve the issues generated by the windfalls.

Taken together, these results point to a strong effect of oil royalties on local level political equilibria. The findings are in line with the predictions of the theoretical model, and can easily be applied to any location where government revenue is strongly determined by exogenous shocks with a cyclical nature. Understanding how these shocks determine politicians' decisions is important for constructing policies that will help improve accountability and selection of politicians, both by reducing opportunities to steal once in office and creating more stable incentives through time. Insulating local governments from international price fluctuations could be an effective way to achieve better governance outcomes in these places.

Some areas of future work which could extend and improve upon the research presented here include: (i) better identifying citizen-candidates opportunity costs of entering into politics, (ii) extending the time horizon so that the world does not "end" on the second period, and thus allowing for mayors to run for higher offices, and (iii) a more in depth analysis of the welfare effects of alternative policies by running more counterfactual exercises. With regards to (i), data on average salaries for different occupations at the municipality level are available through RAIS and CAGED datasets, however data on mayoral salaries which would represent a mayors non rent income from holding office are not public. I am currently working on gathering data for mayors' salaries in Brazilian municipalities from 2000-2020 through an in depth search of municipality websites and a set of transparency requests. This dataset could also be used on work looking at the incentives that salaries create for attracting qualified politicians and other politician career concerns work in Brazil. With regards to (ii), it may be important to allow for politicians to have a longer time horizon than two periods only, especially when we see that a non negligible number of mayors go on to run in future elections as state or federal deputies. Incorporating this concern into the model will more accurately represent the incentives of second term mayors when deciding how much corruption to engage in, and may provide more nuanced results. With regards to (iii), taking into consideration the distributional and welfare effects of counterfactual policies such as alternative

royalty distribution rules and counter-cyclical spending rules is a natural next step in this work, which I hope to continue in the coming months.

As shown in this dissertation, a possible way of preventing the break in accountability caused by resource windfalls could be to isolate governments from the large fluctuations in windfalls caused by resource price volatility. Sovereign wealth funds and anti-cyclical fiscal rules are some of the ways in which this goal can be attained, and might be an effective way to address the negative consequences produced by these windfalls and achieve better governance. Brazil has attempted to move in this direction, establishing a Social Fund (Fundo Social) established in 2010, from which only the dividend could be spent. Initially, only 50% of the dividends created by the fund's investments would be used for education expenditures. However, political pressure and slow economic growth caused the country to reverse the policy and allow for 50% of the total amount in the fund (the principal) to be used in health and education expenditures, virtually eliminating the stabilizing role that the fund was initially crated to serve. Finding the political support and coalitions to back up a proper stabilization fund would be an important step forward in Brazil's struggle to grapple with income from royalties.

Another way of decreasing the pernicious effects of windfalls on corruption could go through the entry mechanism. If we can find ways to dissuade dishonest politicians and convince honest ones to compete, then a large part of the negative effects of these windfalls could be avoided. Policies such as Ficha Limpa ("Clean Record Act"), passed in 2010 which bars candidates who do not have a clean record from holding public office for eight years after their conviction, are an attempt at improving the pool of candidates. Further policies in line with this may be an important way to forward for local politics in Brazil.

Beyond the policy considerations, the current royalty distribution scheme has been the subject of contention and many laws have been proposed in an effort to change it. However, until now substantial change has not been achieved in the rules of distribution. This dissertation hopes to shed some light on the effects of the current royalty distribution and possible effects of alternative distribution rules. Future work could use the framework presented here to explore welfare effects

of alternative distributional arrangements in an effort to design a welfare enhancing policy. The current distribution of royalties has created a strong coalition of revenue rich municipalities formally represented by the Organization of Oil Producing Municipalities (Organização dos Municípios Produtores de Petróleo - OMPETRO). These municipalities have been strong advocates for maintaining the current royalty distribution rules, and have successfully avoided substantial changes to such rules. Future work looking at the role that this coalition will play in efforts to transition from oil to cleaner sources of power will be crucial to understand how Brazil can tackle its carbon emissions.

The results presented in this dissertation provide a cautionary tale for other countries which receive large resource windfalls, especially those that distribute the windfalls to their local governments based on similar rules. Countries like Peru, Ecuador, Colombia and Bolivia all have similar geographic royalty distribution schemes for either oil or mineral exploitation, whereby geographic locations in which the resources are exploited receive an outsized share of the total royalties. This dissertation shows that these locations are likely to be exposed to the same cyclical shocks I have outlined here for the case of Brazilian municipalities. Insulating local governments from the cyclical effects of windfalls could be an important policy to decrease the pernicious effects of windfalls on political accountability in these places. Further, countries like Guyana and Suriname, which have recently discovered substantial oil reserves stand to benefit a great deal from the lessons learned here as they design the institutions surrounding their newfound oil wealth, and decide on the ways in which they will distribute and manage this sudden source of government revenue.

8 Appendix

8.1 Placebo Tests

In this section, I run a series of placebo tests in order to ensure that the results I am getting are not spurious correlations. The results are presented in Table 8.1. In columns 1 and 2, I create a randomized corruption variable with the same distribution as the real corruption variable, but assigning values randomly to municipalities. I run the regressions on this variable to test whether the correlations I find are spurious. If the correlations were spurious and a product of data structure, we might find significant effects in this placebo test which would invalidate the results obtained above. However, I find no effects of any variable on this "Placebo Corruption" variable, indicating that the correlations found above are not just a product of the data structure.

Columns 2 and 3 present the results of a similar exercise. Instead of randomizing the corruption variable, I now randomize the royalties variable, using the same distribution as the real royalties variable. Again, I see no effects of the placebo royalties variable on corruption, indicating that the effects found above are not spurious.

As a final placebo test, I run the same regression as the one in Table 8.1 but using the mayor's gender as the dependent variable. There is no reason to expect female candidates to be elected more often in places with more royalties, so this serves as a test of reliability of the data. Again, we find no correlation between royalties and female mayors, as expected. Interestingly, female mayors are more likely to be college educated, and less likely to be term limited, indicating that they were less likely to be reelected in the previous election.

Table 8.1: Placebo Test: Randomly assigning corruption and royalty values to check for spurious correlations

	(1) Placebo Corrupt	(2) Placebo Corrupt	(3) Corruption	(4) Corruption	(5) Female	(6) Female
Royalties	0.00104	-0.00109			0.0000233	-0.0000136
Royalty Placebo			-0.000673	-0.000462		
PIB		-0.00938		-0.740*		-0.0155
PIB Capita		-0.00229		0.0407		0.000531
PMDB		-0.0551		0.0183		0.00198
PSDB		0.257		-0.651		-0.00135
PT		-0.287		-0.314		-0.0114
College Educ		0.183		-0.458		0.0479***
Term Limited		0.258		1.027**		-0.0223***
Industry		-0.0327		0.943		0.0156*
Services		-0.0547		0.489		0.0151
Proportion Urban		-0.116		0.325		0.0113
Taxes		0.0168		0.604		0.0119
Total Revenue		0.00136		-0.00655		-0.00000504
Federal Transfers		0.00205		-0.00339		0.00000705
Total Expenditure		-0.00141		0.00896		0.000000837
Administrative Exp.		0.00181		-0.00370		-0.00000895
Observations	2257	2133	2293	2016	15536	11887
R-Squared	0.00722	0.0122	0.0262	0.0510	0.0143	0.0259

Regressions include state, lottery and term fixed effects. SEs clustered at State level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

8.2 Robustness

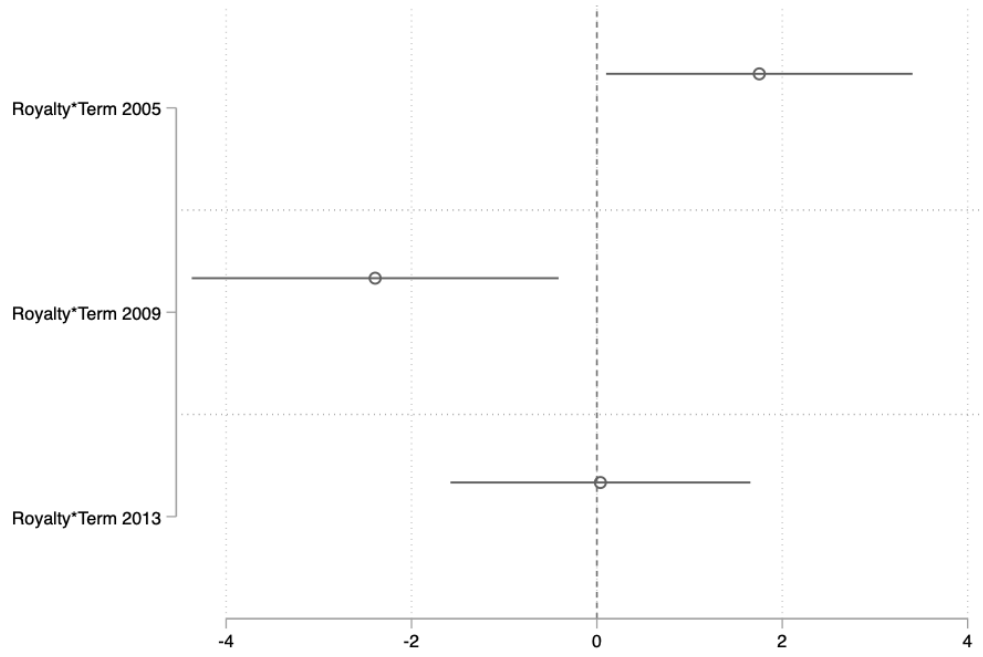


Figure 8.1: Robustness Using Only AFF Data

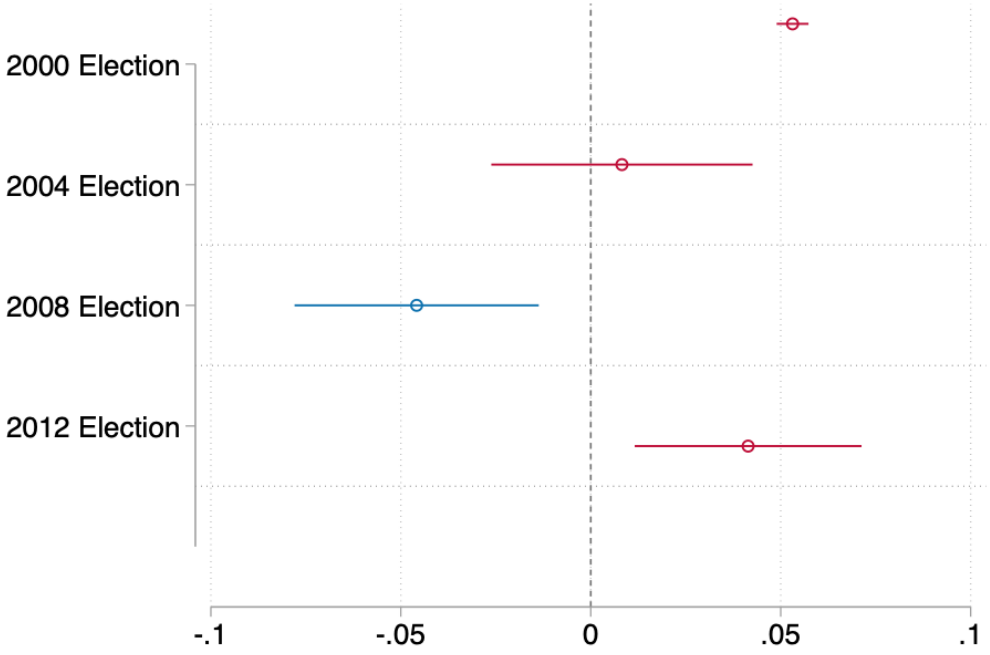


Figure 8.2: Only Elections Pre-Audit Release

8.3 Tables

Table 8.2: Regressions of Royalties On Corruption Levels: Dependent Variable is Corruption

	(1) Indicator	(2) Indicator	(3) Std Royalties	(4) Std Royalties	(5) Log Royalties	(6) Log Royalties
Oil Municipality	3.583*	3.620*				
	(2.82)	(2.62)				
Royalties St			3.664***	3.672***		
			(9.43)	(6.36)		
Log Royalties					0.479**	0.461**
					(3.47)	(3.51)
Population		-4.001		0.229		-4.075
		(-1.19)		(0.07)		(-1.23)
Municipal GDP		5.436		-3.855		5.314
		(0.98)		(-0.54)		(1.02)
Federal Transfers		5.153		2.569		5.008
		(1.90)		(1.20)		(1.92)
Taxes		-3.528		2.274		-3.326
		(-0.80)		(0.43)		(-0.81)
College Education		-0.0747		0.136		-0.0592
		(-0.11)		(0.18)		(-0.08)
Female		-2.298		-2.634		-2.412
		(-0.96)		(-1.13)		(-1.00)
Term Limited		1.812*		1.457		1.782*
		(2.29)		(1.98)		(2.25)
PT		0.400		0.540		0.339
		(0.20)		(0.28)		(0.17)
PSDB		-3.001		-3.094		-3.054
		(-1.35)		(-1.39)		(-1.36)
PMDB		-0.967		-0.883		-1.037
		(-0.82)		(-0.77)		(-0.89)
Observations	2600	2224	2600	2224	2600	2224
R-Squared	0.289	0.274	0.313	0.294	0.292	0.276

t statistics in parentheses
Regressions include state and term fixed effects. SEs clustered at State level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.3: Regressions of Royalties On Corruption Levels: Dependent Variable is Corruption Indicator

	(1) Indicator	(2) Indicator	(3) Sd Royalties	(4) Sd Royalties	(5) LnRoyalties	(6) LnRoyalties
Oil Municipality	0.378***	0.353***				
	(6.62)	(7.63)				
Royalties St			0.0126*	0.00968		
			(2.63)	(1.62)		
Log Royalties					0.0315***	0.0292***
					(6.99)	(7.79)
Population		0.0529		0.0999		0.0611
		(0.97)		(1.57)		(1.02)
Municipal GDP		0.0426		0.127		0.0742
		(0.55)		(1.23)		(0.69)
Federal Transfers		-0.0290		-0.0572		-0.0459
		(-0.87)		(-1.49)		(-1.20)
Taxes		-0.0734		-0.174		-0.103
		(-1.16)		(-1.85)		(-1.07)
College Education		-0.0165		-0.0114		-0.0139
		(-1.12)		(-0.66)		(-0.96)
Female		-0.0296		-0.0160		-0.0316
		(-1.28)		(-0.62)		(-1.37)
Term Limited		0.0103		0.0177		0.0114
		(0.69)		(1.15)		(0.79)
PT		-0.00633		0.00770		-0.00528
		(-0.21)		(0.25)		(-0.18)
PSDB		-0.0306		-0.0339		-0.0350
		(-0.67)		(-0.67)		(-0.75)
PMDB		0.00711		0.0132		0.00480
		(0.32)		(0.57)		(0.22)
Observations	2600	2224	2600	2224	2600	2224
R-Squared	0.331	0.326	0.254	0.263	0.320	0.316

t statistics in parentheses

Regressions include state and term fixed effects. SEs clustered at State level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.4: Regressions of Royalties On Corruption Levels: Dependent Variable is Corruption Indicator

	(1) Indicator	(2) Indicator
Royalty*Term 2001	6.802**	9.197**
	(3.23)	(3.23)
Royalty*Term 2005	3.440*	3.692*
	(2.68)	(2.39)
Royalty*Term 2009	-5.669*	-5.987*
	(-2.35)	(-2.63)
Royalty*Term 2013	11.44	10.89
	(1.82)	(1.65)
Population		-4.364
		(-1.29)
Municipal GDP		5.943
		(1.05)
Federal Transfers		5.435
		(2.00)
Taxes		-3.877
		(-0.93)
College Education		-0.0955
		(-0.13)
Female		-1.858
		(-0.74)
Term Limited		1.736*
		(2.31)
PT		0.481
		(0.26)
PSDB		-2.984
		(-1.44)
PMDB		-0.750
		(-0.62)
Observations	2600	2224
R-Squared	0.302	0.287

t statistics in parentheses
Regressions include state and term fixed effects. SEs clustered at State level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.5: Regressions of Royalties On Corruption Levels: Dependent Variable is Corruption

	(1) First Term	(2) Second Term	(3) First Term	(4) Second Term	(5) First Term	(6) Second Term
Oil Municipality	2.060	6.627*				
	(1.35)	(2.57)				
Royalties St			3.144*	4.513***		
			(2.67)	(5.61)		
Log Royalties					0.264	0.890**
					(1.88)	(3.23)
Population	2.310	-0.497	14.49	4.310	2.240	-0.670
	(0.89)	(-0.04)	(1.17)	(1.48)	(0.89)	(-0.05)
Municipal GDP	3.315	30.74	1.213	-1.012	3.319	28.87
	(0.85)	(1.58)	(0.06)	(-0.15)	(0.89)	(1.55)
Federal Transfers	1.740	14.51*	3.523	0.360	1.685	13.64*
	(0.75)	(2.23)	(0.83)	(0.16)	(0.75)	(2.31)
Taxes	-5.760	-103.4	-86.89	-3.003	-5.700	-98.80
	(-1.92)	(-1.91)	(-1.64)	(-0.61)	(-2.03)	(-1.94)
College Education	-0.159	-1.324	-0.711	0.0152	-0.141	-1.330
	(-0.20)	(-1.03)	(-0.52)	(0.02)	(-0.18)	(-1.05)
Female	-1.362	-6.697*	-7.311**	-1.631	-1.424	-7.026*
	(-0.52)	(-2.76)	(-3.09)	(-0.64)	(-0.54)	(-2.82)
PT	0.794	-2.394	-2.165	0.952	0.772	-2.605
	(0.36)	(-0.56)	(-0.58)	(0.43)	(0.36)	(-0.62)
PSDB	-3.081	-3.253	-4.009	-2.936	-3.123	-3.273
	(-1.30)	(-1.23)	(-1.44)	(-1.24)	(-1.31)	(-1.26)
PMDB	-1.787	1.280	0.988	-1.691	-1.829	1.123
	(-1.49)	(0.65)	(0.48)	(-1.46)	(-1.53)	(0.58)
Observations	1643	581	581	1643	1643	581
R-Squared	0.290	0.272	0.288	0.309	0.291	0.279

t statistics in parentheses

Regressions include state and term fixed effects. SEs clustered at State level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.6: Regressions of Royalties On Reelection Rates By Year: Dependent Variable is 1 if Incumbent Won Reelection

	(1) 2000 Election	(2) 2004 Election	(3) 2008 Election	(4) 2012 Election	(5) 2016 Election
Royalties St	0.0613**	0.0352*	-0.0411*	0.0165	-0.0307*
	(3.23)	(2.38)	(-2.57)	(1.25)	(-2.44)
Population	0.0133	-0.0783	0.0202	-0.0841	0.0324
	(0.22)	(-1.06)	(0.27)	(-1.50)	(0.55)
Municipal GDP	0.0806	0.145	-0.246	0.115	-0.0469
	(0.10)	(0.70)	(-1.68)	(1.27)	(-0.67)
Federal Transfers	-0.0334	-0.0387	0.112*	-0.0114	0.0243
	(-0.65)	(-0.45)	(2.50)	(-0.41)	(1.14)
Taxes	0.143	0.00779	0.176	-0.0423	0.00917
	(0.89)	(0.03)	(1.08)	(-0.46)	(0.14)
College Educated	0.0164	0.0122	0.0104	-0.00298	0.0190
	(0.78)	(1.07)	(0.76)	(-0.25)	(1.63)
Female	-0.0528**	-0.0623**	-0.0735**	-0.0563**	-0.00699
	(-2.87)	(-2.92)	(-3.17)	(-3.10)	(-0.39)
PT	-0.00683	-0.0413	-0.00313	0.0124	0.139***
	(-0.97)	(-1.90)	(-0.14)	(0.66)	(5.08)
PSDB	0.0230**	0.0490**	0.0355	-0.00700	0.0466**
	(2.98)	(3.12)	(1.77)	(-0.39)	(2.76)
PMDB	0.0242	0.0118	0.0466**	0.0263	0.0142
	(0.92)	(0.81)	(2.75)	(1.70)	(0.94)
Observations	4310	5278	5248	5484	5349
R-Squared	0.00330	0.00661	0.00719	0.00368	0.00841

t statistics in parentheses
Regressions include state. SEs clustered at State level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.7: Regressions of Royalties On Reelection Rates: Dependent Variable is 1 if Incumbent Won Reelection

		(1)
		Reelection
Royalties*2000 Election	0.00474	(0.28)
Royalties*2004 Election	0.0378***	(7.96)
Royalties*2008 Election	-0.00840	(-1.01)
Royalties*2012 Election	0.00600**	(3.25)
Population	0.0330	(0.55)
Municipal GDP	-0.00883	(-0.07)
Federal Transfers	0.0346	(1.03)
Taxes	-0.0511	(-0.60)
College Education	-0.00488	(-0.17)
Female	-0.0756	(-1.39)
PT	0.0899*	(2.50)
PSDB	-0.0132	(-0.26)
PMDB	-0.0706*	(-2.15)
Observations	1463	
R-Squared	0.0566	

t statistics in parentheses
Regressions include state and term fixed effects. SEs clustered at State level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.8: Regressions of Royalties On Likelihood of Running for Reelection By Year: Dependent Variable is 1 if Incumbent Ran for Reelection

	(1) 2000 Election	(2) 2004 Election	(3) 2008 Election	(4) 2012 Election	(5) 2016 Election
Royalties	0.0531***	0.00820	-0.0458**	0.0414**	-0.0287
	(24.88)	(0.47)	(-2.80)	(2.72)	(-1.91)
Population	0.0752	-0.0900	0.0568	-0.0311	0.122
	(1.12)	(-1.03)	(0.75)	(-0.48)	(1.75)
Municipal GDP	-0.399	-0.126	-0.144	0.0895	-0.0430
	(-0.42)	(-0.51)	(-0.96)	(0.86)	(-0.52)
Federal Transfers	0.0028	-0.0318	0.0447	-0.0355	-0.00714
	(0.56)	(-0.31)	(0.97)	(-1.12)	(-0.28)
Taxes	0.390	0.496	0.0338	-0.0613	-0.0266
	(0.78)	(1.64)	(0.20)	(-0.58)	(-0.35)
college	0.0375*	0.0299*	0.00346	-0.0298*	0.0102
	(2.37)	(2.21)	(0.25)	(-2.18)	(0.74)
female	-0.0485	-0.0607*	-0.0316	-0.0159	0.00123
	(-0.69)	(-2.39)	(-1.33)	(-0.76)	(0.06)
pt	0.0276	0.0144	0.00310	-0.0141	0.0592
	(0.49)	(0.55)	(0.13)	(-0.65)	(1.82)
psdb	0.0087	0.0245	0.0355	-0.00596	0.0540**
	(1.03)	(1.31)	(1.72)	(-0.28)	(2.68)
pmdb	0.00837	-0.0110	0.0311	0.00835	0.0245
	(0.38)	(-0.64)	(1.79)	(0.47)	(1.37)
Observations	4310	5278	5248	5484	5349
R-Squared	0.128	0.00382	0.00363	0.00341	0.00398

t statistics in parentheses
Regressions include state. SEs clustered at State level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.9: How are offshore_royalties affecting government expenditures?

	(1) Educ	(2) Sec	(3) Judic	(4) Assist	(5) Agro	(6) Admin	(7) Health	(8) Hab	(9) Energy
Offshore Royalties	-0.324***	0.0129	0.00589	0.0181	0.0397**	0.264*	-0.236**	0.198*	-0.0114
PIB	16.75	-0.829	0.264	-3.787	3.596**	7.184	-0.895	-21.55*	2.623
PIB Capita	-0.105	-0.0811	0.00495	-0.145	-0.0131	-0.186	-1.418*	1.202***	-0.0842
PMDB	0.182	-0.118	0.105	1.134	-0.481	-2.141	-1.366	0.213	-0.335*
PSDB	2.178	-0.404	-0.145	1.444	0.0742	-2.904	1.774	-1.191	-0.261
PT	1.861	-0.520	-0.623	2.711	-0.330	-7.012	-8.984	5.986	-1.465*
College Educ	1.924	-0.247	-0.0828	1.250	0.586	-1.483	-3.714*	1.163	-0.0844
Term Limited	-0.750	0.393	0.0505	0.254	0.310	-3.626	-1.535	2.306*	-0.153
Industry	-18.02*	1.396	-0.365	2.357	-2.826*	0.493	3.289	13.71	-1.895
Services	-35.76***	1.174	0.318	7.668	-4.326**	-9.831	14.33*	24.01**	-2.972
Proportion Urban	39.98***	0.576	-0.930	-2.821	-0.526	27.81***	-35.45*	-17.59**	0.252
Taxes	9.388	0.383	-0.511	3.050	-4.422**	-6.286	1.609	12.55	-2.555
Total Revenue	0.307***	0.0108**	-0.00218*	0.0612***	0.00365	0.0854***	0.143***	0.206***	0.000854
Federal Transfers	-0.108	-0.0220	0.00609	-0.0234	0.0129	-0.0509	0.316***	-0.0460	0.00908
Observations	1605	1605	1605	1605	1605	1533	1605	1605	1605
R-Squared	0.963	0.610	0.275	0.869	0.486	0.811	0.950	0.888	0.282

Sample includes only municipalities for which we have Corruption data. Includes state and term fixed effects. State level clustered SE.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8.10: How are offshore_royalties affecting government expenditures?

	(1) Educ	(2) Sec	(3) Judic	(4) Assist	(5) Agro	(6) Admin	(7) Health	(8) Hab	(9) Energy
Offshore Royalties	-0.280***	0.00544	0.00425	0.0595	0.00959	0.404**	-0.208**	0.106	-0.00636
Corruption	0.112	-0.0203	-0.000134	-0.0175	-0.0188	0.0776	0.134	-0.0282	0.00677
Offshore Royal*Corruption	-0.00550***	0.000757**	0.000196	-0.00381**	0.00276***	-0.0121***	-0.00244	0.00679**	-0.000522*
PIB	14.64	-0.918	0.344	-3.421	3.625**	7.686	-1.373	-21.32*	2.595
PIB Capita	-0.203	-0.133	0.00176	-0.283	-0.00622	0.104	-1.195	0.957*	-0.0111
PMDB	-0.252	-0.153	0.137	0.483	-0.316	-2.034	-0.968	0.0407	-0.197
PSDB	1.975	-0.307	-0.167	1.250	0.260	-3.793	1.768	-0.901	-0.327
PT	-0.348	-1.078	-0.591	3.425	-0.488	-3.992	-10.06	5.609	-1.217*
College Educ	2.902	-0.414	-0.0943	0.985	0.395	0.429	-4.491**	1.130	-0.0323
Term Limited	-0.671	0.354	0.0286	0.480	0.206	-2.937*	-1.258	1.730	-0.106
Industry	-14.92	1.761	-0.434	3.036	-2.929*	-1.845	2.738	14.86	-2.254
Services	-34.75***	1.488	0.278	7.660	-4.189**	-11.62	15.67*	23.51*	-3.040
Proportion Urban	42.57***	0.938	-0.937	-2.259	-0.704	26.20***	-39.52**	-14.78*	-0.479
Taxes	12.38	0.643	-0.604	1.913	-4.106**	-10.64	-0.672	16.86	-3.081
Total Revenue	0.311***	0.00908*	-0.00230	0.0591***	0.00169	0.105***	0.141***	0.200***	0.00248
Federal Transfers	-0.123	-0.0255*	0.00546	-0.0324	0.0165*	-0.0577	0.344***	-0.0530	0.0141*
Observations	1516	1516	1516	1516	1516	1449	1516	1516	1516
R-Squared	0.964	0.671	0.291	0.881	0.580	0.809	0.953	0.911	0.311

Sample includes only municipalities for which we have Corruption data. Includes state and term fixed effects. State level clustered SE.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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