

The Politics of Unconventional Oil: Industrial and Technology Policy in Brazil, Malaysia, and Mexico

by

Renato Lima de Oliveira

B.A., Federal University of Pernambuco (2004)
M.A., University of Illinois at Urbana-Champaign (2011)

Submitted to the Department of Political Science
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
at the
Massachusetts Institute of Technology

June 2017

©2017 Renato Lima de Oliveira



The author hereby grants MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part in any medium known or hereafter created.

Signature redacted

Signature of Author: _____

Department of Political Science
May 18, 2017

Signature redacted

Certified by: _____

Ben Ross Schneider
Ford International Professor of Political Science
Thesis Supervisor

Signature redacted

Accepted by: _____

Ben Ross Schneider
Ford International Professor of Political Science
Chair, Graduate Program Committee

The Politics of Unconventional Oil: Industrial and Technology Policy in Brazil, Malaysia, and Mexico

by

Renato Lima de Oliveira

Submitted to the Department of Political Science on
May 18, 2017 in Partial fulfillment of the
requirements for the Doctor of Philosophy in
Political Science

ABSTRACT

The oil industry has been an important source of industrial and technological development for countries like the United States, United Kingdom, and Norway but is mostly associated with a range of negative outcomes by the resource curse literature. Studies in this tradition assume that this industry has limited potential for creating local jobs, fostering a domestic supply chain, and interacting with research institutions. Instead, the oil industry is treated as a pure generator of easy rents that flow to governments, which unless they are constrained by good institutions, will turn resource wealth into negative economic and political outcomes. This study questions the core assumptions of the resource curse literature. It does so through a careful analysis of the industry's characteristics and the varying sources of rents, showing the existence of Schumpeterian (innovation) rents in natural-resource production. It then provides a theory that connects geological endowments to political incentives and predicts when natural resources lead to rent-capture or creation, the types of rules of distribution of oil wealth and institutional complementarities put in place to manage it, and the conditions under which policies to foster local economic participation are more likely to emerge (local content policies). The theoretical framework is then applied to the study of three countries that have similar background conditions but have different geological endowments – one traditionally rich in low-cost oil, which is Mexico, and others which are abundant in high-cost, hard-to-get O&G, which are Brazil and Malaysia. It shows that a change in the resource base pushed policymakers in Mexico to replace the rules of the sector with a constitutional reform that aligned incentives for long-term investments, attracted private capital, relied less on oil rents for public finances, and promoted local procurement. In Brazil and Malaysia, this study shows that the technically challenging aspect of producing oil and gas in those countries both enabled and incentivized a new type of distributive and industrial policy in the natural-resource sector, politicizing supply contracts but also investing in domestic capabilities, innovation, and pockets of efficiency within the state bureaucracy.

Thesis Supervisor: Ben Ross Schneider

Title: Ford International Professor of Political Science

Table of Contents

Acknowledgments	8
Chapter 1: Introduction	11
1. The puzzle and the argument	11
2. Observable implications, methodology and case selection	17
3. Overview of the dissertation	23
Chapter 2: The politics of unconventional oil	28
1. Introduction	28
2. The resource curse argument	31
3. The industry value chain and the role of states	35
4. From rent capture to rent creation	37
5. The politics of local content	51
6. Conclusion	58
Chapter 2 Appendix: The process of reserve creation and the industry value chain	60
Chapter 3: From Geology to Public Policies in Mexico: Explaining the Constitutional Reform in the Oil Sector	67
1. Introduction	67
2. The state, resource endowments and the rules of the natural resource sector	70
3. Mexico's oil sector over time	77
3.1. The 1960s and 1970s: From relative scarcity to abundance	77
3.2. Living off rents: From the 1980s to the mid-2000s	82
4. When rents become scarce: the reformist era	88
4.1. Old geological challenges in a new administration	92
4.2. Rules of access to resources and the regulatory framework	97
4.3. Rent-taking: adjusting rents to investment opportunities	100
4.4. Industrial and technology policies (local content)	102
5. Conclusion	108
Chapter 5 Annex 1: Cost of production of fields in operation in 2006	111
Chapter 5 Annex 2: Cost of developing new reserves, per asset	111
Chapter 5 Annex 3: Total employment at Pemex (1995-2015)	112
Chapter 5 Annex 4: Pemex, selected financial indicators	113
Chapter 5 Annex 5: Summary of changes by the energy reforms	114
Chapter 4: When rents are secondary: Brazil's industrial and innovation policies in O&G	115
1. Introduction	115
2. From oil-poor to the "Saudi Arabia" of deep offshore: Brazil's key changes in the rules of distribution of oil wealth	117

2.1. The explanatory framework	117
2.2. Evolution of the rules of access to resources and government take	119
3. Petrobras: Innovating to create rents from a challenging geology	122
4. Promoting local content	128
4.1. Local content clauses in the concession contracts	130
4.2. Public-private coordination: Prominp	135
4.3. Direct government purchase: Promef and Sete Brasil	138
5. Conclusion	142
Chapter 4 Annex 1: Commitment to Local Content – Production-Sharing Contract (2013)	146
Chapter 4 Annex 2: Map of shipyards in Brazil as of 2014	154
Chapter 5: Greasing the wheels of coalitional presidentialism in Brazil: the <i>Petrolão</i> Scandal	155
1. Introduction	155
2. Geological endowments, innovation, and political incentives in the upstream and downstream	159
3. Oil rents greasing the wheels of coalitional presidentialism	162
3.1. The “Carwash” operation	162
3.2. Measuring political activity by suppliers	165
3.3. Direct costs of bribes	168
3.4. Political use of Petrobras’ investments	173
3.5. Price subsidies	175
4. Conclusion	179
Chapter 5 Appendix 1 - Campaign donations by different groups (2006)	182
Chapter 5 Appendix 2 - Campaign donations by different groups (2010)	183
Chapter 5 Appendix 3 - Campaign donations by different groups (2014)	184
Chapter 6: Geology, not institutions: Malaysia’s oil industry success amidst strong ethnic distributive pressures	186
1. Introduction	186
2. Malaysia: challenges of nation-building in a multi-ethnic society	190
3. Theoretical expectations	193
4. The creation of Petronas and negotiating with oil majors	197
4.1. From early explorations to the creation of Petronas	197
4.2. Building a market for natural gas	201
4.3. Building a Malay business class through oil contracts (local content)	203
4.4. Becoming an oil operator and expanding overseas to sustain the domestic supply chain	208
4.5. Adjusting government take and promoting more investments	210
4.6. Assessing the limits of the geologically-based incentives and alternative hypotheses	212
5. Conclusion	215

Chapter 7: Conclusion	218
1. Rethinking the role of extractives in the process of development	218
2. Findings	221
3. Practical implications	227
3.1. Design of industrial policies in local content	227
3.2. Lessons for conventional oil producers	231
4. Theoretical implications	234
Appendix: List of interviews	240
References	244

ACKNOWLEDGMENTS

Many steps, political and technical, precede the decision to drill a well that may eventually find oil and gas (O&G). The drilling activity serves both to test hypotheses advanced from indirect knowledge as well as to generate new data. During the drilling process, a team of experts collects the fragments (rock samples) and uses this information to trace back the geological history of the area. The sequence of layers and the types of rocks found provide tips about the long process which may have resulted in forming a column of oil and gas – the much desired commercial objective. We do not directly observe the process, only the final result, and with these many pieces we try to solve geological puzzles.

What you have here is the product of many years of work and the generosity of many people. Acknowledgments are an exercise in digging in your own past, in tracing back the many people who influenced the way you think about issues, conceptualize theory, and go about testing it. And, definitely no less important, those who did stand by you in providing an environment adequate for reflection and personal support. Some readers will only see this final version and will have missed the process which led to this document. However, this work is also composed of many layers, sediments made by the influence of people and organizations that I had the pleasure of interacting with over the course of this study and my professional work. Here I provide its stratigraphy.

My first contact with the oil industry was working as a business journalist at *Jornal do Commercio de Pernambuco*, Brazil, in the mid-2000s. My assignments included covering the implementation of billion dollar investments of a new refinery, petrochemical plants and shipyards in the state. Not a single drop of oil is produced in Pernambuco, but it was politically well connected and benefited from the spillovers of the growth of Brazil's oil production and local content policies. I covered each early step of these investments, from government announcements, to the public hearings of their environmental impact assessment, and, finally, their ribbon-cutting ceremonies. From initial announcements to first production, I witnessed the enormous public-private mobilization in public goods, such as investment in complementary infrastructure and human resource training. Many colleagues and sources helped me during my early career, among whom I would like to highlight Maria Luiza Borges, Jamildo Melo, Saulo Moreira, Bianca Moura, Adriana Guarda, Giovanni Sandes, Sílvia Menezes, José Carlos Cavalcanti, Cláudio Marinho, and Tiago Cavalcanti.

At the University of Illinois at Urbana-Champaign (UIUC) I received my first graduate training in social sciences and I am very grateful for the guidance and support of José Antonio Cheibub, whose intellectual influence led me to pursue a PhD in Political Science. I am thankful for the support and inspiration from Werner Baer (in memoriam), Joseph Love, Angelina Cotler, Luciano Tosta, Paulo Vaz, Gustavo Sampaio, Breno Sampaio, and Luiz Figer.

MIT was a challenging and rewarding intellectual environment. Thankfully, I was lucky enough to have Ben Ross Schneider as a mentor and advisor. I could not ask for a more attentive and generous scholar to guide me in the long process of writing a dissertation. For his suggestions, encouragement and example as a scholar I will be forever grateful. F. Daniel Hidalgo and Matthew Amengual went above and beyond as committee members and have also played a key role in my graduate training and thesis development, helping to improve my work at every occasion, for which I am thankful. I am also especially grateful to Ken Oye, Mike Piore, Suzanne Berger, Rick Locke, Chappel Lawson, Kathlen Thelen, Roger Petersen, David Singer, Lucas Stanzyk, Don Lessard, Elizabeth Reynolds, and Timothy Sturgeon. I had the opportunity to present some of the drafts of this work at the Harvard-MIT Latin American Dissertation Group (LADG), and I would like to thank Jorge Dominguez, Steve Levitsky, and Fran Hagopian. For additional feedback and encouragement, I also thank Rodrigo Bandeira-de-Mello, Francisco Monaldi, Marcus André Melo, Antônio Botelho, Yuri Kasahara, Gerald McDermott, Stanislav Markus, Pauline Jones Luong, Paasha Mahdavi, Matheus Batalha, Andre Acetose Nascimento, Celson Lima, Sílvia Meira, Peter Boettke, Paul Dragos Aligica, Christopher Coyne, Monica de Bolle, and Monica Pinhanez. In addition to my home department of Political Science at MIT, I was lucky to benefit from the institutional generosity of the MIT Industrial Performance Center (IPC), the MIT Energy Initiative, the MIT Center for International Studies (CIS), the MIT International Science and Technology programs (Brazil, Chile, France, and Mexico), the Total Summer Energy School, the Harvard Geopolitics of Energy program, the Rule of Law Collaborative program at USC, the Kellogg Institute at Notre Dame University, Senai, the Institute for Humane Studies (IHS) and the Mercatus Center at George Mason University, and the Charles Koch Foundation.

Having done fieldwork in three different countries, I incurred a debt of gratitude to many people who generously shared their time and knowledge with me. I am very grateful to Roberto Ponce, Azucena Rojas, Lourdes Melgar, Marco Cota, Gerson Vega, Benjamin Hill, Griselda Gomez, Alma América Porres, Nicolás Dominguez Vergara, Jesus Reyes Heróles-Garza, Adrian Lajous, Jomo K. S., Adeline Lee, Zalina Jamaluddin, Charles Fine, Loredana Padurian, and David Capodilupo. Many of my fellow colleagues

provided me valuable feedback and camaraderie along the way and I would like to acknowledge Martin Alonso, Tesalia Rizzo, Danilo Limoeiro, Yue Hue, Yiqing Xu, Laura Chiro, Ezequiel Zylberberg, Cristina Caldas, Yuri Ramos, Cauam Cardoso, Amanda Rothschild, James Conran, Silverio Zebral Filho, Kacie Miura, Ignacio Puente, Marika Landau-Wells, Mayumi Fukushima, Justin Montgomery, Nara Pavão and Fernando Bizarro. I would also like to thank the help of Susan Twarog, Rosabelli Coelho-Keyssar, Susan Spilecki, Rebecca Thorndike-Breeze, Paula Kreutzer, Helen Ray, Maria DiMauro, Janine Sazinsky, Laura Guild, Diane Gallagher, and Anita Kafka.

By spending much time in the Boston area at MIT or doing fieldwork in Mexico City, Rio de Janeiro, and Kuala Lumpur, I lost many precious moments with my family. Thankfully, my brief returns home were full of joy. For all the support and encouragement, I would like to thank my uncles, aunts, cousins and in-laws. Above all, my parents, Carlos Fernando and Maria Nélia, and my brother Luis Fernando. Michelle Padua, my partner, was with me at every moment of this project and I cannot praise her more for all her “rock solid” love, friendship, and intelligence.

Chapter 1:

Introduction

1. The puzzle and the argument

When in 2007 Petrobras, Brazil's National Oil Company (NOC), announced the discovery of a large ultra-deep offshore oil province beneath a layer of salt, the pre-salt, euphoria took over the country. The new resources, with capacity to multiply the total reserves of the country, would be Brazil's passport to the future, claimed the then-president Luiz Inácio Lula da Silva. The pre-salt would provide revenues to be channeled to education and science as well as industrial demand for drilling rigs and platforms, which would be manufactured mostly in Brazil due to stringent local content requirements. A dozen shipyards sprawled over the coast to manufacture oil tankers, floating production platforms and drilling rigs, activating a large supply chain throughout the country even before any drop of oil from the pre-salt started to flow.

The first pre-salt field to be discovered was located in the block BM-S-11, acquired in 2000 by a consortium of Petrobras (65%), BG (25%) and Galp (10%) in a bidding round following the end of Petrobras' monopoly, in 1997. The first challenge of the consortium was to identify the potential of the block: standard seismic analysis, used at that time, could not see what was below a thick layer of salt. After developing novel seismic techniques, while still facing uncertainty, the consortium decided to drill a very costly well over 2,200m of water depth, 5,000m of rock and 2,000m of salt. There, a discovery was confirmed in 2007 and only in 2010 was the field declared commercial, with the start of production, and it received the official name of "Lula." It took, therefore, ten years from the initial exploration to the actual start of production. The ramp up of volume took even longer as the first platform contracted specifically for the field, the P-66 at a cost of \$1 billion, only became ready in February of 2017, with about one year of delay due to the manufacturing in Brazilian shipyards, with the hull made in the state of Rio Grande do Sul, modules in Alagoas and final integration and system testing in Rio de Janeiro. In addition to local content (hereafter, LC) clauses in exploration contracts, Brazilian lawmakers put into a 2010 law that for the pre-salt area, any new offer of exploratory blocks would have to take into account the industrial capacity of the country in the supply chain. The pre-salt in Brazil generated jobs and contracts for local business groups long before it produced rents for the country. It also activated specific scientific programs to support the technological development of the new oil province,

strengthening Petrobras' R&D institution (Cenpes) and its network of research partners all across the country, which receive more than a \$1 billion a year for R&D.

In 1977, Mexico had a similar large discovery that resulted in a national euphoria centered on the activities of its state oil company, Pemex. It was the field of Cantarell, the second biggest oilfield by production in the world, second only to Ghawar from Saudi Arabia (IEA 2008, p. 225) and located in very shallow waters (35m). Reportedly found by a fisherman who complained to Pemex of oil stains in his fishing nets in the area, it was developed in the record time of two years by Pemex, with all planning and technology outsourced to Brown & Root, a subsidiary of the American Halliburton. The decision by then Mexican president José Lopez Portillo was to do it as fast as possible in order to bring rents sooner and fund his budget priorities, a strategy that effectively sidelined the local industry, which did not participate in the development of Mexico's most important oil field (García Páez 1989). Pemex's own R&D center, IMP, was also put aside, becoming a provider of technical services to Pemex rather than a source of scientific advancements. Cantarell was quickly put into production: it started in 1979 and already in the second year it had an output of 612 thousand barrels per day (kbpd). In contrast, in the Lula field of Brazil, production took much more time to begin and even five years after the start of production, in 2010, its output was significantly lower: 400 kbpd (ANP 2016).

In Mexico, a large oil discovery, developed with foreign expertise, quickly resulted in new rents for the government, repeating an enclave development model long associated with the development of large export-commodity projects. In Brazil, on the other hand, the pre-salt oil province was found through the development of novel technologies, with high local participation, and the investment required to put it into production served to fuel an industrial demand of locally supplied oil equipment and services. In both countries, euphoria was later replaced by disappointment, as lower oil prices drastically changed the valuation of their recently-discovered wealth. Notwithstanding this, the way each nation chose to manage its oil wealth was radically distinct.

Why has the oil industry in Brazil being used to promote broader industrial and scientific demand in the supply chain while in Mexico it just provided rents for the government? The difference in policy outcome is puzzling on the Brazilian side. What happened in Mexico is in line with standard accounts of the political and economic effects of extractive industries in developing countries, prototypical types of enclave development, with no connection to the rest of the economy of the country – lacking the backward and forward linkages that Hirschman (1958) and others talked about. More generally, it is believed that the oil industry is not likely to impact local economies with the

exception of rents because, as Ross (2012, p. 45) claims, oil companies “buy relatively few inputs from local firms and thus generate few backward linkages to the local economy.” Why do these standard accounts fit so well to explain the Mexican development of Cantarell but so poorly to account for the rise of Brazil’s oil industry and the policy decisions for the pre-salt and other deep-offshore assets in that country to buy, to the maximum extent possible, equipment made locally?

The answer advanced in this study starts in the distinct geological endowments of the two countries. Geological challenges affect political incentives that shape the societal bargain that produces the rules of distribution of oil wealth. Geology affects the incentive-structure associated with the rules that define who can extract, how much rents will go to governments (government take per barrel), and under what procurement rules (benefiting or not a domestic supply chain). Both Lula da Silva, in Brazil, and López Portillo, in Mexico, responded to political calculations on how to best use the newly discovered wealth, but they faced different constraints and opportunities.

A geology-centered approach represents a substantive departure from the tradition of studies in this area of inquiry. Studies from the large and multifaceted resource curse literature have in common the use of measures of resource wealth as independent variable to explain a myriad of dependent variables. Where many scholars working in this field start by asking whether a country is oil-rich (e.g. Ross 2012), or when it became so (e.g. Smith 2007), or how choices such as state ownership of resource extraction affect it (Luong and Weinthal 2010), I take a step back and ask what kind of geological endowment it has. Is it an easy to extract, low cost, O&G resource? Or an endowment that is technically complex, high-cost, and with a long lead time for its development? This distinction, ignored by the current political science literature on the resource curse, is critical to understand the economic and political effects of resource wealth and will shape societal demands and the rules of distribution of resources. While a solid literature has been established on the political and economic effects of conventional oil production, this study is the first to relate geological challenges of producing unconventional resources to political outcomes.

It does not take much to illustrate the critical difference that resource endowments can have. To start, let us assume an oil price of \$50. Let us say that in country A it takes just \$1 to produce a barrel, given an easy geology of effortlessly accessible onshore reservoirs with low declining rates. Such a barrel, sold at \$50, will generate \$49 of rents. Country B, which produces oil from a technically complex ultra-deep reservoir, utilizes \$45 of capital and operational expenditures for each barrel produced. The barrel from country B will be sold to the international market for the same \$50. However, the maximum

amount of rents which will accrue to each country will be substantively different: \$49 versus \$5 per barrel.

In country A, the jackpot is to have access to the \$49 of rents. In country B, substantive sums of money are involved in the productive activity of the oil industry – the \$45 of cost per barrel required to pay for the drilling rigs, production platforms, supply vessels, logistic services, etc. Those who are part of this long production chain benefit from oil wealth as well. In fact, they can be the first to profit from it, as projects with long lead time (such as deep offshore) will require investments for years, as much as a decade, before production begins. Therefore, if politics in conventional oil producers *is all about rents*, for unconventional producers *it is also about contracts*. In fact, it can be more about contracts, making rents secondary, as the case study of Brazil will show. The first major contribution of this study is to reveal and theorize that in high-cost oil production key political issues are contracts and LC policies.

Therefore, how oil wealth *is shared*, the distributive demands on oil riches, and how cost of production affects the types of claims made by interest groups, will differ under conditions of geological challenges. However, an antecedent issue is the source of such wealth: is it the result of *capture or creation*? Conventional oil producers have the luxury of sitting on a favorable geology that can easily be discovered – even by a fisherman, as in the case of Cantarell. In such situation, oil wealth is captured by the state through high-levels of taxation (government take) and/or direct production by a state company. On the other hand, unconventional producers have to go through many hoops. First, they have to see what others frequently do not (as in the case of seismic analysis revealing oil under salt domes). Then, they have to excel in technical capacity, such as by reaching deeper and deeper water depths while managing all the associated technical and environmental challenges of deep offshore production. Or, in the case of O&G from shale, combine technologies, such as horizontal drilling and hydraulic fracturing, in order to extract oil from rocks with low porosity and permeability. Their end product will be the same – a barrel of oil – but it was extracted by innovative means that combined technologies to produce an old commodity in a new way, fitting one of Schumpeter's definition of innovation (1942). The second contribution of this study is, thus, to show that the oil industry can be a source of innovation and that oil rents can also come from Schumpeterian rents. Together, this study reveals new developmental possibilities for oil-rich countries as well as new political battlegrounds over the rules that guide the extraction and distribution of oil wealth.

Oil and gas are omnipresent commodities in the contemporary life given their role as sources of electrical energy (particularly natural gas), transportation fuel (mostly from oil), and petrochemicals

(which can be produced either from oil or natural gas). This long value chain starts with the identification of resources, where O&G are likely to be found, and continues through production, refining, petrochemical transformation and retail. This study focuses on the upstream segment – the activity of exploration and production (E&P) – because it is the one that concentrates most of the rents of the industry (Tordo et al. 2011) and is where the distinction of conventional and unconventional oil is relevant because it can be a source of different distributive pressures and incentives for innovation. After a barrel of oil is produced, regardless of its sources, it can be refined with off-the-shelf technologies, in virtually any place in the world, in a market where margins are tight and where the state loses the power to set the regulations of extractive activities that originates from sovereign subsoil rights.¹

Figure 1.1 provides an analytical model that connects varying levels of extraction costs to the outcome studied in this work: the rules of distribution. Low extraction costs allow states to maximize their rent-capture through high government take per barrel produced. Interest groups have an incentive to appropriate the oil rent directly through, for instance, energy subsidies and above market wages for NOC employees. On the other hand, where extraction costs are high, the executive is more constrained in its ability to tax the resource sector, as high taxes can more easily discourage new investments and shutdown current production. Furthermore, lower rents per barrel put a limit on the amount of subsidies, overemployment and above market wages that are distributed using oil revenues. This is a result of the combination of lower availability of rents, per unit produced, and the increased need of companies in the upstream to have a lean cost structure to commercially extract oil from high-cost, low-margin reservoirs. The executive is also more likely to open the sector for private participation to share geological risks and the high-capital requirements with long lead times of unconventional resources, such as in deep offshore, and invest in institutional complementarities that can reduce production costs, such as in educational and scientific organizations.

¹ These points on industry characteristics and the varying distributive pressures and innovation incentives are addressed in an Appendix to Chapter 2 and in Chapter 5.

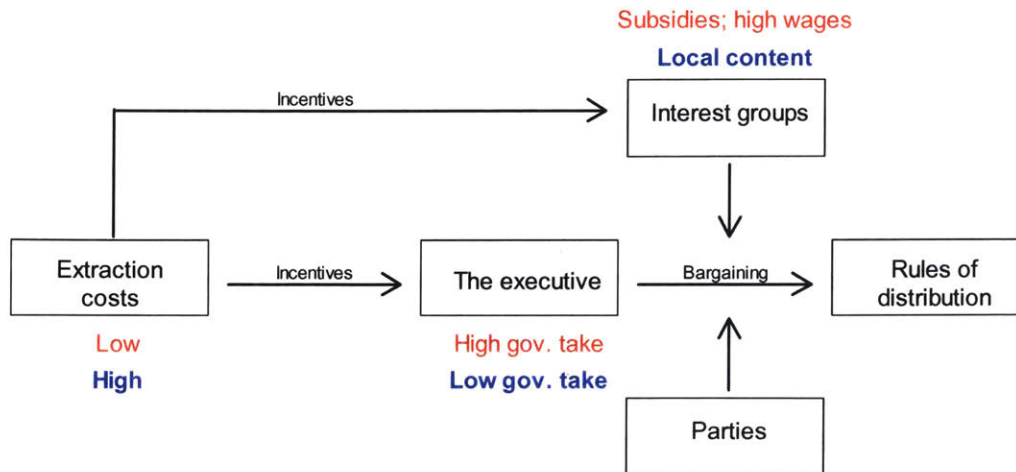


Figure 1.1: From extraction costs to rules of distribution

For local suppliers and workers, high cost of production represents an opportunity to benefit from oil wealth by participating in the supply chain. This leads to pressures to influence the rules that determine the procurement strategies of oil companies – a dynamic that I term contract-seeking – and is consolidated in LC mandates. The executive, thus, has to balance its distributive pressures in the supply chain with an efficiency imperative required to promote and sustain the oil industry under more challenging geological conditions.

While the pressure for local content is related to the absolute amount of capital expenditures per barrel, the market disciplining effect of operating under low margins by extracting predominantly from high-cost oil assets is relative: it will be less intense under periods of high oil prices. In the long run, I expect oil companies (including NOCs) that predominantly operate high-cost oil assets to be more innovative and efficient to stay in business competing with firms that extract from conventional oil. However, the oil industry is notorious for price fluctuations and, as the executive from the Italian ENI oil company Leonardo Maugeri writes, “there is nothing like a period of high prices to make the worst investment decisions ever” (Maugeri 2006, p. 142). To Maugeri’s assertion, I add, for NOCs, that high oil prices make it more likely for them to be subject to rent-seeking because of the temporary soft budget constraint. Nonetheless, such effects will be mitigated by the lower availability of rents per barrel (in comparison to conventional producers) and the need for tougher adjustments during cycles of low oil prices in order to break even.

I unpack the rules of distribution of the oil sector – the dependent variable of this dissertation – by focusing on the study of who can participate in the extraction process, the government take per barrel, and the procurement regulations (local content). These three variables, together, define how societies manage the distribution, broadly conceived, of subsoil wealth. The first relate to the rules of access to resources. Government direct participation through NOCs is one form of capturing oil wealth (by directly producing it or by holding an equity participation) and a key reason for nationalizations of the sector (Mahdavi 2014, Tordo et al. 2011). However, while state companies may capture existing wealth, restrictions on the participation of the private sector may hinder the creation of reserves, particularly for resources that have high geological risk, and technical and capital requirements. The second variable, government take, is the direct taxation of resources and is the most straightforward way that oil rents can flow to governments. Government take varies from as low as 25% to as high as 98%, depending on geological risk, type of resource (natural gas, light oil, heavy oil), and institutional risks (Van Meurs 2008).² Government take is essentially proportional to how easy and valuable production is; easy and cheap production potential can maximize the public rent component of oil wealth. Finally, LC requirements, by influencing the procurement strategies of oil companies, can channel resources to suppliers and workers located in the country where extraction takes place rather than to exporters of oil equipment and expatriate workers. In sum, the rules that define access to resources, taxation level per barrel and procurement regulations define the distribution of oil wealth and are analyzed over time in the empirical chapters of this study.

2. Observable implications, methodology and case selection

This study advances the hypothesis that production of a commodity at the knowledge frontier – where costs of production are high and rents from scarcity, monopoly and differential costs are not available or are marginal in comparison to traditional producers – gives rises to a different set of incentives to resource-owners and interest groups. Rather than focusing only on strategies of rent-capturing, resource-owners are more likely to adopt strategies that also include rent creation

² Government take is defined as “government receipts from royalties, taxes, bonuses, production or profit sharing and Government participation divided by cash flow” (Johnston 2008, p. 52). Not only is the total taxes collected important, but also how the fiscal systems are designed: progressive systems provide more incentives for investments and allow governments to automatically capture more rents when prices and production are high, reducing the incentives for contract renegotiations.

(Schumpeterian) and linkages with domestic companies (local content). As part of the toolkit to promote investments in the sector and channel it to local producers, interest groups will bargain with the executive and party representatives. From these negotiations I expect to see lower direct rent-taking (government take) to stimulate production from high-cost resources and competition of investment in the upstream (rather than public monopolies) to share geological risks and capital costs. Additionally, strategies to support the growth of the oil sector include funding R&D and human resource training, adopting industrial policies to broaden domestic capabilities in the supply chain, and strengthening state institutions responsible for regulating and supporting the sector.

Resource curse theorists normally attribute the positive outcomes observed in cases like Norway, Canada or Australia to national-level institutions. This is sometimes poorly specified, as is the case of “producer friendly” versus “grabber friendly” (Mehlum et al. 2006) or “high-quality” (Robinson et al. 2006) institutions. In addition, these accounts tend to treat these institutions as orthogonal to the resource sector, without careful consideration of how the rules associated with the resource sector can themselves be shaped by its internal productive dynamics. Qualitative studies that analyze historical experiences of successful resource-led growth and how the state, lead firms and suppliers interacted defy the conventional narrative of low productivity and knowledge creation potential of the resource sector (de Ferranti et al. 2004, Hatakenaka 2006, Ville and Wicken 2012, Wright and Czelusta 2004). However, most of these studies tend to focus on a handful of cases of countries which also rank high in general indexes of institutional quality. This brings two methodological issues. The first regards external validity of the conclusions beyond the cases of high-income countries analyzed. Second, and related, they suffer from selection bias because their analyses are focused on explaining the successful cases of resource-led development. Although these studies are very valuable for shedding light on the potential mechanisms that link resource-abundance with development and innovation, they fall short in identifying causal explanations.

To address these concerns, this study does a structured, focused comparison (George and Bennet 2005) of countries that are similar on background conditions but have different geological endowments – one traditionally rich in low-cost, conventional oil, which is Mexico, and others which are abundant in high-cost, hard-to-get O&G, which are Brazil and Malaysia. I combine the focused comparison with in-case process-tracing, using two qualitative methods to make stronger causal inference (Bennett and Checkel 2015). This methodological choice allows us to learn both from the

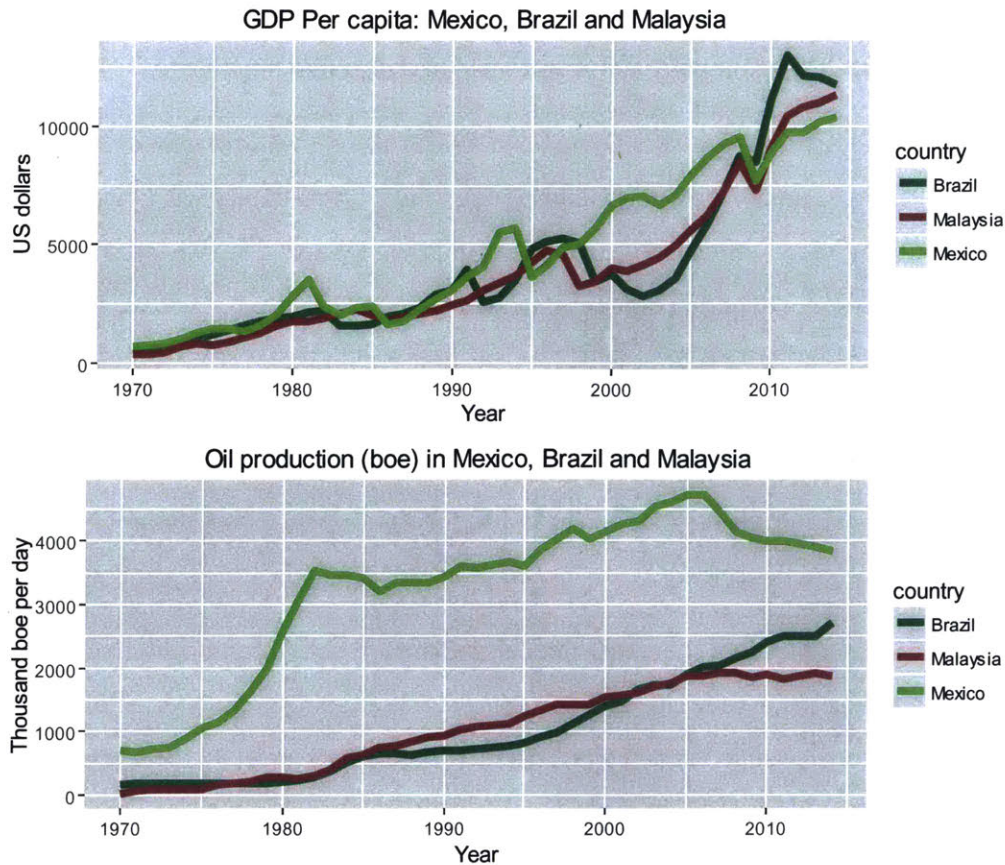
comparison of cases and from the historical sequence and mechanisms through which the rules associated with the resource sector has been constructed and disputed over time.

Case comparisons are the workhorse model of inference in qualitative studies and remain an indispensable tool for internal and external validity (Slater and Ziblatt 2013). A qualitative examination is a very needed contribution to the resource curse literature that has relied heavily on cross-country statistical analysis³ with some enduring debates hinging on modelling assumptions⁴ or the endogeneity of resource wealth (Dunning 2010, B. Smith 2012, Brooks and Kurtz 2016), which brings obvious problems for inferences based on cross-country quantitative studies. As Stevens and Dietsche (2008) recognize, there are limitations on accounts that ignore time and historical contexts and this brings opportunities for comparative studies that analyze the conditions under which natural resources countries are able to escape the curse.

Mexico, Brazil and Malaysia show remarkable similarity in background conditions that allow parsing out the effect of a technically challenging geology in developing skills and capabilities in the resource sector and how oil wealth triggered distinct distributive pressures. All three countries had nationalized their resources and chosen a flagship state-owned enterprise (SOE) to manage the oil sector: Pemex, Petrobras and Petronas, respectively. Mexico traditionally had access to a low-cost oil resource – particularly during the boom of the late 1970s – and did not adopt industrial policies in the oil sector, while both Brazil and Malaysia developed higher-cost offshore oil and invested in promoting LC policies. Furthermore, all three countries have very similar income levels (see Figure 1.2) and have a common history of state activism in promoting development.

³ Karl (1997) is an important exception and, more recently, Hugues (2014).

⁴ For example, on the relation of oil and democracy, see Haber and Menaldo (2011) and the rebuttal of Andersen and Ross (2014).



Source: BP 2016 and World Development Indicators

Figure 1.2: GDP per capita and oil production in Mexico, Brazil, and Malaysia

The within-case analysis is particularly rich for the Mexican and Brazilian cases due to the variance over time. In Mexico, the resource base changed from a low-cost and simple-to-extract reality to high-cost deepwater, mature fields and unconventional O&G, which has lower rents per barrel but more industrial and technological demand. Policymakers replaced the old legal framework with one that aligned incentives for long-term investments, attracted private capital and relied less on oil rents for public finances. In the process of bargaining the new rules of the sector, new political coalitions were forged to overcome legislative veto points. This resulted in losses to Pemex’s workers’ union, heavily invested in the old legal framework, in favor of the support of the business class interested in more supply opportunities that can come from the market opening and a newly adopted LC policy. The reform also strengthened the regulatory role of the state, increased investments in R&D to support the growth of production from complex reserves, and reengaged the Mexican state in industrial policy.

The Brazilian Petrobras has a very strong history of technological innovations and of serving broad national development goals, such as promoting domestic suppliers. In order to develop its costly deep offshore resources, Brazilian lawmakers opened the oil sector in 1995 to partner with private companies, what allowed Petrobras to share risks. The rules of the market opening included earmarking oil rents for R&D applied in local universities and an LC policy that became stronger over the years, leading to a large domestic supply sector. The discovery in 2007 of the ultra-deep pre-salt fields was seen as the culmination of a long successful business trajectory of Petrobras at the same time that the company served as an anchor for an ambitious industrial policy. However, after innovation allowed Petrobras to unlock the new resource wealth, it fell prey to intensive distributive and political pressure, with suppliers overcharging the company and paying kickbacks to political parties, in a dynamic of innovation with rent-seeking. The comparison between Mexico and Brazil reveals how much more important technological development and LC investments were in Brazil's oil politics and how Mexico, after depleting its cheap oil reserves, transitioned to a governance structure similar to the one found in Brazil.

The argument advanced in this study could have been empirically tested with the comparison of Mexico and Brazil, and many comparative studies of state and development have relied on a two-case design (e.g., Sikkink 1991, Kang 2002). Mexico and Brazil have more similar population, colonial history, and political systems than is the case of Malaysia. However, there are several advantages of including Malaysia to the study. The simple comparison of Mexico to Brazil would be very revealing but would not rule out alternative hypotheses concerning the adoption of LC and efforts to build an ecosystem of innovation in the oil industry. Both Brazil and Mexico have a past of import substitution industrialization (SI), and Brazil's LC could be conceived as a deeper penetration of ISI in Brazil. More significantly, Mexico's budget is highly dependent on hydrocarbon production, while Brazil's is not, and this could help explaining why policies on the oil sector took different routes.

The additional selection of Malaysia as case study strengthens the comparative leverage of this study. The export-oriented Malaysia adopted LC (a least likely case, in that regard) and resorted to the O&G sector to create jobs and promote local companies owned by the bumiputera⁵ ethnic groups as part of its New Economic Policy (NEP), equally politicizing contracts in the O&G sector, but with an ethnic goal. Moreover, Malaysia has relied more on oil rents than Brazil for public revenues. In order to accommodate the social target of ethnic inclusion with economic efficiency, Petronas invested in

⁵ A Malay word for sons of the soil, referring to the indigenous population.

funding scholarships for Malaysian workers and in industrial policies that would increase, with efficiency, the participation of bumiputera companies in Petronas' total purchases. Far from having institutions classified as best-practices for the oil sector (Thurber et al. 2011), the Malaysian oil industry remained competitive, this research shows, by its geological constraints of small reserves with low rents that have kept in check domestic rent-seeking.

Table 1.1, below, summarizes the cases across key time periods and variables. Brazil is analyzed over two periods, and costs of production have gone from medium to high. Government take throughout Brazil's history has been of marginal importance to the federal government. Instead, the focus of policymakers has been on developing suppliers and investing in R&D, rules that private operators also have to follow since the opening of Brazil's oil sector in the late 1990s, which was key to bring the capital necessary to unlock deep water reserves. For the pre-salt specifically, after 2010, given its large reserves, low exploratory risk, and high-cost of production, the Brazilian government changed its rules to increase rent capture at the same time that kept a strong LC policy. Mexico is equally analyzed under two key moments. There, costs started very low and the rules of distribution prioritized government take and the monopoly of Pemex in access to resources. With costs going up, and Pemex unable to revert a production decline, politicians had an incentive to reform the sector, reducing the government take to stimulate new investments and opening up for private operators. High-cost oil also attracted the interest of suppliers in LC, and the preference for Mexican goods, services and labor was put into law during the energy reform. Finally, in Malaysia, since Petronas was created in 1974 by the Malaysian government, the rules of distribution have been stable and designed to benefit the procurement of goods and services from the bumiputera. Government take has been linearly reduced over the years to stimulate investment in the sector, which has always been open for IOCs.

Table 1.1: Cost of production and rules of distribution

Cases	Cost of production	Private sector participation	Government take	Local content
Brazil (1954-1994)	Medium	None, government monopoly	Very low	Petrobras's own supplier development programs
Brazil (1997+)*	High	Through competitive open bidding rounds	Low	Formal, specified in contract
Mexico (1938-2012)	Low	None, government monopoly	High	None
Mexico (2013+)	Medium/High	Through competitive open bidding rounds	Lower, decided by bidding conditions	Formal, specified in contract
Malaysia (1974+)	Medium/High	Through competitive direct negotiations with Petronas	Adjusted to production and resource type; lower over time	Formal, through local licensed vendors; preference for bumiputera-owned companies

* After 2010, government take was raised but only to the pre-salt area

3. Overview of the dissertation

This study is divided in seven chapter. Following this introduction, Chapter 2 develops a theory of the political and economic consequences of unconventional oil production. It starts by highlighting how technology allowed the United States to revert its declining oil production and surpass Saudi Arabia in total O&G output. The growth of US production has been concentrated in unconventional fields which yield a much lower rent per barrel than a field like Ghawar in Saudi Arabia, but has activated a large supply chain and made fortunes to oil entrepreneurs and land owners. Far from representing an anomaly, it is argued that since the beginning of oil exploration the US has had an industry of marginal fields that can barely pay for their cost of production, a situation that has stimulated oil entrepreneurs to seek technological solutions to sustain these businesses and reduce the risks involved in the operation. In marginal fields or those at the frontier of technology, technical solutions can make or break fortunes, representing an important source of Schumpeterian rents.

Chapter 2 questions the core assumptions of the resource curse literature by doing a careful analysis of the industry characteristics and the varying sources of rents, showing the existence of Schumpeterian (innovation) rents in natural-resource production. It then provides a theory that connects geological endowments to political incentives and predicts when natural resources lead to rent-capture or creation, the types of rules put in place to manage the natural resource sector, and the conditions under which policies to foster local economic participation are more likely to emerge (LC policies). A second analysis is how oil firms react to LC policies, which is shown to be a new form of distributive pressure triggered by abundance of high-cost/unconventional oil resources. Chapter 2 provides the analytical framework which is used throughout the empirical chapters of this study.

Chapter 3 addresses the case of Mexico, a country where the resource base changed from a low-cost and simple-to-extract reality to high-cost deepwater, mature fields and shale O&G. The theory's predictions developed in Chapter 2 are used to explain the shape and timing of the institutional changes observed in Mexico's energy reform of 2013, which ended Pemex's monopoly and introduced a framework to reduce the state dependency on oil revenues. Mexico's institutional model of high fiscal dependency on oil rents, operation by a monopolistic state company with low efficiency, and limited investments in exploration and R&D could only be sustained, I argue, if similar resource endowments (i.e., low cost giant fields with low exploratory risk) were easily available. As the country's prospective petroleum resources require more capital expenditures and have a lower rent per barrel, policymakers replaced the old institutional framework with one that aligned incentives for long-term investments, attracted private capital and relied less on oil rents for public finances. In the process of changing the distributive rules of the sector, politicians forged a new coalition to support LC as a way to overcome legislative veto points: the adoption of LC requirements was key to obtain support for the reform from nationalistic sectors within the PRI and to benefit the main constituency of the business-oriented PAN. Overall, the Mexican case shows how a change of resource endowment can lead to deep political changes with implications to the role for the state in the economy and adoption of industrial policy through LC requirements.

I dedicate two chapters to Brazil. Chapter 4 shows how the history of the oil industry in Brazil provides a stark contrast to the enclave model of resource development, typical of conventional oil producers, where little to no spillovers impact the economy, with the exception of fiscal rents that flow to public budgets. Brazil's National Oil Company (NOC), Petrobras, was created in 1953 in an oil-poor country with the mission to find and develop O&G in Brazil – or abroad, if necessary. Rather than

managing plentiful rents from easy oil production, Petrobras required creating rents, through Schumpeterian innovation, to thrive, and it did so by being a leader in deep offshore oil production. The company also played a key role in Brazil's developmental state ambition of replacing imports, both of capital and of crude oil – a mission that continued even during periods of market opening. This chapter identifies in the country's geology a key variable to understand Brazil's oil politics and related institutional changes. It shows that Brazil's geology and political incentives were in line to adopt innovation and industrial policies in the oil sector – both in the period of oil scarcity as well as abundance of high-cost oil, after the discovery of the pre-salt formation in 2007. Brazil's oil distributive rules are the result of a bargaining process between lawmakers, the executive and interest groups, where institutional changes respond to geological risks, capital requirements, oil prices and political pressures to promote industrial demand through LC requirements. The Brazilian case highlights how high-cost oil can beget a politics centered on contracts and investment in human resources and R&D.

At the same time that Petrobras was achieving production self-sufficiency and founding new reserves in ultra-deep waters, a network of corrupt contractors, executives and politicians was using the growth of investment capacity of the NOC for personal and political gains, in a major corruption scandal that is addressed in Chapter 5. This chapter shows that in the mid-2000s there was a brief moment where institutions remained the same but key historical characteristics of Petrobras changed: production increased making the country virtually self-sufficient in 2006, with new discoveries that opened the perspective of becoming an important exporter, at the same time that high oil prices increased its margins of operation. Together, these factors abolished Petrobras' traditional hard budget constraint and strategic role that had preserved it from party-clientelistic practices and mismanagement.

Chapter 5 also argues that given Brazil's geological endowments, Petrobras could better serve open political purposes if the company continued to create rents through Schumpeterian innovation in deep offshore, thus expanding the firm's total oil reserves, production, and creditworthiness. Innovation supported Petrobras' other activities, which later included politically-driven investments, bribe extraction, and gasoline price subsidies. Using a variety of data sources, including plea bargain statements and a spreadsheet of bribe rates of large projects, Chapter 5 shows how bribes and economic losses differed across industry segments, with the downstream concentrating more losses than the more innovative and subject to cost pressures upstream – where LC requirements exist. Petrobras' operational capabilities and a track-record of innovation in oil extraction led to successful

discoveries of new reserves that paradoxically facilitated political interference by easing historical constraints that had spared the company from political exchanges. The evidence corroborates the argument that the driving force behind Petrobras' success as a NOC was the context in which it operated, its geological challenge, rather than just national level institutions that supposedly constrained political meddling.

Malaysia, the topic of Chapter 6, is the case that provides the most direct refutation of the view that institutions are the sole differentiator between oil blessing or curse. Malaysia defies standard policy prescriptions for oil-rich countries by having one of the least accountable resource-sector governance, an opaque public budget, and a legal regime that gives the prime minister total control over the country's National Oil Company (NOC), Petronas. Furthermore, Petronas' procurement prioritizes purchases from suppliers and trading firms that have local ethnic groups as shareholders and workers – the bumiputeras. Despite the country's institutional weaknesses, the NOC figures among the best performing (Thurber et al. 2011) and is considered to be "efficient and honest" (Stiglitz 2007, p. 39) and a role model for other NOCs (Marcel 2006). If institutions do not constrain rent-seeking and inefficiency at Petronas, what does? Chapter 6 shows that a key variable to understand Malaysia's success in managing the resource sector at the same time that it redistributes wealth through preferential contracting is the country's geological characteristics. The high cost of developing resources constrained rent-seeking and favored policies to develop local suppliers and bring them to international competitiveness standards. This chapter sheds light on the role of non-institutional constraints in the oil sector and provides another example of LC policies as redistributive tools.

Chapter 7 concludes by tying all the cases together and suggesting areas for further research. The main message is that if abundance of unconventional oil opens up new developmental possibilities and distributive conflicts, as claimed in this study, important theoretical and policy implications follow. First, that the resource curse literature should be more mindful of geology as key a variable that affects the volume of rents per barrel and the distributive demands of local interest groups, particularly as production of oil from unconventional sources grows in the world. Second, that policymakers and practitioners involved on natural resource management need to more closely engage with issues of industrial policy design and monitoring. Third, that the growth of production from unconventional sources will pressure the political economy of conventional producers, as it will limit the amount of monopoly and Ricardian rents that they can exploit. However, even conventional producers can benefit from R&D that are linked to the demand from the oil sector. More generally, the development of local

capabilities in the supply chain and knowledge institutions can be an important factor in turning a black and viscous commodity, so commonly associated with negative outcomes, into societal welfare.

Chapter 2:

A theory of innovation and industrial linkages in the O&G value chain

1. Introduction

Saudi Arabia has been for years the biggest oil producer in the world, with an output in 2014 of 11.5 million barrels per day (mbpd). About half of the production comes from a single field: Ghawar, which was discovered in 1948. Production started three years later and since then Ghawar alone has been responsible for 7% of the world's oil output (IEA 2008, 2013). Like other super-giant oil fields in the Middle East, Ghawar has spectacular geological conditions for producing oil, with high permeability, volume, and low decline rate, generating an immense amount of rents for the Saudi Kingdom with very little need of investment.

Saudi's decades-long dominance in the world oil ranking has recently been challenged by the United States, which in 2014 produced 11.7 mbpd (BP 2016). Unlike in Saudi Arabia, US production does not come from a super giant field, but from thousands of high-cost fields, including deep offshore reservoirs of the Gulf of Mexico or from onshore shale rocks that had oil and gas (O&G) trapped inside them, requiring a combination of technologies such as horizontal drilling and hydraulic fracturing for extraction. This unconventional production has sizable operational costs and output declines much faster, requiring constant new investments in drilling new wells and in cost-reduction technologies. Production from deep offshore has different characteristics, but also has high demand for solutions that reduce costs and enable further exploration of frontier areas.

Since the beginning of oil exploration, the US has had an industry of marginal fields that can barely pay for their cost of production. Oil entrepreneurs have had to seek technological solutions to sustain these businesses and reduce the risks involved in the operation. In the chronicles of the oil industry (Raymond and Leffler 2006), technicians such as Erle Halliburton, Harry Cameron and the Schlumberger brothers are known for their innovative contributions to the industry as well as for the names of companies that to this day are still leaders in manufacturing solutions for the extractive industry. In fields where the cost to produce a barrel is close to or above the price of oil in the market, technical solutions can make or break fortunes.

The standard view of the oil industry in economic development and political science is of the Ghawar field: an immense reservoir that contributes very little in terms of employment, technology, and

human capital of a country. On the other hand, it is manna in the desert in fiscal terms, generating huge profits with little effort. Sometimes staffed by expatriates who live in company compounds, such extractive industries are referred as prototypical types of enclave development, with no connection to the rest of the economy of the country – lacking the backward and forward linkages that Hirschman (1958) talked about.

This image of an extractive industry describes the realities of many countries, but by no means all of them. Among the most developed nations are cases of resource-rich countries like Norway, Canada, and Australia (Ville and Wicken 2012, de Ferranti et al. 2002). The technological and industrial development of the US was greatly facilitated by the demand generated in the resource sector (Wright and Czelusta 2004). As a positive feedback process, the resource sector demanded technology and supporting institutions, and technological advancements further enabled new resource expansion, as the growth of production of O&G from shale has shown. Even developing countries, such as Brazil and Malaysia, have resource sectors that are substantially different from the enclave image because they are lead sectors in terms of domestic industrial demand, investments in human capital, and R&D.

The traditional view of natural resources and development tends to overlook the successful cases of resource-led growth or attribute those achievements to the quality of national-level institutions in preventing fiscal resources from being squandered. In short, the mechanism postulated by the mainstream political economy literature works through revenue management. Rents from natural resources tend to accrue to governments. Leaders who are unchecked in their ability to use those rents and be held accountable will more likely coopt sectors of society, repress opposition, enrich themselves and their allies through corruption, and waste resources in “white elephant” projects. As a result, preexisting institutions that limit executive power are necessary to curb the negative effect of oil bonanzas (Mehlum et al. 2006, Robinson et al. 2006).

Common to this view is the neglect of an analysis of the natural resource sector, and oil in particular, as an industrial complex which under some conditions can be leveraged for technological development. In addition, as will be argued here, different geological endowments can also be a source of constraints to executives and a driving force in shaping the rules of the resource sector. The traditional resource curse literature, focused on rent capture and spending, is ill-equipped to explain technological contributions coming from oil production, as well as distributive rules such as the growth of policies that require backward linkages through local content mandates. This is particularly relevant because discoveries of super giant low-cost onshore fields like Ghawar belong to the past as oil

production becomes more complex and ventures into frontier areas of high-cost of production, with different distributive implications and potential developmental outcomes.

This study is motivated by the puzzling fact that for some countries natural resources have been very important for local industries and knowledge institutions, such as universities and research centers, even in countries who do not share the same quality of institutions found in the US or Norway, which is counter to the expectations of the resource curse theory. To solve this puzzle, I investigate how geological endowments and industry-specific characteristics affect political incentives of policymakers, who are responsible for crafting the rules of distribution that govern how natural resources are extracted and how rents from them are distributed. I study, thus, the creation and evolution of the critical rules of the resource sector – the definitions of who can extract, under what tax level (government take), and whether local suppliers are prioritized (local content). These are the laws, regulations, and policies which define how societies manage the distribution, broadly conceived, of subsoil wealth. These variables are formalized in laws and contracts and are decided by politicians after bargaining with firms and interest groups, since states are sovereigns of subsoil rights⁶ (Mommer 2002), and ultimately responsible for setting the industry rules. I start from a thorough analysis of the value-chain of the O&G industry and how a rational firm decides to invest for exploration, two critical areas to understand the impacts of oil production on the broader political economy but unfortunately understudied in the resource curse literature. From those, I derive predictions of how geological endowments generate incentives for policymakers and how the interaction of these incentives with political institutions and interest groups shape the governance of the resource sector. In doing so, I uncover new areas of distributive conflicts triggered by resource abundance of complex and more costly oil, which are the politics behind local content mandates in O&G.

This chapter proceeds as follows. Section 2 critically evaluates the resource curse literature, with particular attention to the role of oil rents and institutions. Section 3 analyzes the complex value-chain of the O&G industry and the way reserves are created through investments in knowledge and exploratory efforts. The core of the chapter is developed in Sections 4 and 5. Section 4 presents a theory that connects the different types of rents to political incentives that influence the bargaining for the rules related to the resource sector, showing that under challenging conditions of production there is an incentive to engage in rent-creation as opposed to rent-capture. Section 5 predicts the growth and analyzes the characteristics of a novel aspect of distributive politics that exists under conditions of high-

⁶ The United States is an important but unusual exception to sovereign mineral rights.

cost production of resources, which are local content (hereafter, LC) mandates. Finally, Section 6 concludes.

2. The resource curse argument

Social scientists have used the term “resource curse” to refer to a variety of maladies that are associated with resource abundance, such as low growth rate, persistence of authoritarianism (Ross 2001, Tsui 2011, Wright et al. 2015), civil wars (Collier and Hoeffler 2005), corruption and lack of transparency (Ross 2012), reduced work opportunities for women (Ross 2008, Simmons 2016), higher infant mortality (Stevens 2006), and macroeconomic policy volatility (Doyle 2014). The majority of the mechanisms proposed to explain the outcomes work through the availability of rents allowed by resource wealth. The literature does not distinguish the types of rents available for resource-owners and implicitly assumes that their political incentives are the same. Furthermore, economic analyses make a critical assumption that in the natural resource sector there is no learning by doing, positive spillovers or industrial connections to the rest of the economy. This work will challenge these claims and later show how different types of rents relate to political incentives and influence the adoption of rules of distribution.

The “curse” literature originated from the empirical observation from cross-country regressions (Sachs and Warner 1997, Mehlum et al. 2006) and case studies (Auty 1993, Gelb 1988, Karl 1997) that countries rich in natural resources tended to grow slower than their counterparts and have historically wasted huge windfalls. Economists early on tended to emphasize “Dutch Disease” macroeconomic mechanisms, where changes in the relative prices of the economy due to the boom in exports of the primary sector decrease the competitiveness and output of the non-resource sector. “Dutch Disease” would not be a problem if the output from the resource sector could more than compensate for the decline of others. However, it is normally assumed that natural resource production lacks an increasing return to scale technology and positive externalities that are associated with manufacturing processes. This assumption, a claim that goes as far as Prebisch (1950), has led scholars to believe that the sector that has its competitiveness negatively affected is more dynamic than the natural resource sector, thus resulting in long-term adverse consequences through deindustrialization.

The solution to avoid a “Dutch Disease” is straightforward at the national level. The core of the problem lies in currency overvaluation and crowding out of investments by the natural resource sector.

Economic institutions can be put in place that prevent currency exchange overvaluation and smooth consumption of the revenues over time (e.g., a sovereign wealth fund). Another way to increase the competitiveness of the economy outside of the resource sector is to use fiscal expenditures in public goods such as transportation and human capital (Lin 2012).

From the purely economic point of view, the solution to the curse would be trivial as a set of recommendations, or “best practices,” is fully available (Sachs 2007). However, it can demand unreasonable assumptions: it takes a “benevolent planner” to optimally tax the resource sector, use the revenues to enlarge the time horizon of government expenditures, and invest in the “right” activities that increase the competitiveness of the overall economy – all without taking some of the windfall for himself and allies and without significant overhead costs. For this reason, political economy accounts fare better in explaining the maladies associated with resource abundance by explicitly incorporating political incentives in their models. By treating politicians and bureaucrats as rational self-maximizing actors, one gets much closer to understanding why windfalls from natural resources frequently lead to predatory behavior and shortsighted policies by political elites rather than opportunities for long-term development. The main mechanism of such models works through the availability of rents that circulate through government accounts. As owners of subsoil rights, governments either extract oil directly through a National Oil Company (NOC) or authorize private firms to do so in exchange for taxes. Resource booms increase the value of being in power and the ability of incumbents to use government largesse to buy support and repress opposition (Robinson et al. 2006). The soft-budget constraint that resource booms give can lead to a bloated public sector and redistribution to close allies (Bueno de Mesquita et al. 2003, Robinson and Torvik 2009) – in short, inefficient redistribution that makes good politics but bad economics.

The implication of political economy explanations is that, left to themselves, rulers will use the availability of rents from natural resources to achieve their political objectives; these incentives will conflict with good use of resource rents. It then becomes imperative to avoid the curse to have rules that constrain the ability of those in power to dispose of rents as they please. Those rules are “impartial” (Kolstad and Wiig 2009), “producer friendly” (Mehlum et al. 2006) or “high-quality” (Robinson et al. 2006) institutions that regulate public expenditure, impose transparency requirements and hold rulers accountable. By limiting the ability of politicians to engage in inefficient redistribution, it also decreases rent-seeking activities from entrepreneurs (Krueger 1974, Tullock 1967).

The mainstream of the resource curse literature is largely in agreement that institutional quality is the key factor in determining whether resource abundance will be a blessing or a curse (Sarmidi et al. 2014). Then the task becomes specifically identifying these institutions and how they can be implemented (Stevens and Dietsche 2008). Both of these issues are problematic. First, multiple institutions can achieve the same outcome – there is no single mapping from a desirable market outcome to its associated institutions (Rodrik 2000). Second, the process of institutional adoption (or imposition) is an equally thorny issue; institutions change the equilibrium of political actors, and they will have incentives to react against what are considered to be “best” institutions developed elsewhere.

One consequence of taking the political economy arguments seriously is that institutions associated with the resource sector are likely endogenous and they themselves require explanation. As defined by Ostrom (2005), institutions are equilibrium outcomes of repeated interaction of agents. Institutions do not travel easily – they have to reflect an underlying political equilibrium to work (Berkowitz et al. 2003, Moser 2009, Przeworski 2004). Institutions that are born out of equilibrium will be weak and may be replaced or not enforced (Levitsky and Murillo 2013). Given all the challenges mentioned above, the literature has failed to identify how institutions related to the resource sector and the coalitions that backed them were created and evolved over time. Part of the issue may come from the use of the term institution in itself, which has a broad applicability and can refer to several characteristics of the political economy and historical legacies of a country. For these reasons, and considering the key role played by how wealth from oil is shared to oil politics, this work will focus on the rules of distribution of the natural resource sector. I unpack them by focusing on the study of who can participate in the extraction process (access to resources), the government take (how much of the O&G production is captured in the form of taxes), and the procurement regulations (local content requirements). In addition, I refer to institutional complementarities to the resource sector as the institutions that can operate in the coordination of firms across the O&G sector, reinforcing particular ways of producing and competing.

Summing up, while early works stressed the resource curse as an economic phenomenon working through the macro-economy, subsequent scholars increasingly pointed to the role of rents in affecting political calculations. Rather than an economic occurrence, the resource curse came to be seen as a political one, driven by the availability of rents and resource ownership (Collier 2010, Luong and Weinthal 2010, Karl 2007). As Kolstad and Wiig put it, “The resource curse is not about resource

abundance per se, it is resource rents” (2009, p. 5324).⁷ Yet, surprisingly little attention has been paid to a careful analysis of how the different types of rents and geological endowments affect political calculations and, in their turn, the rules associated with the resource sector and the political coalitions that support those arrangements. The literature ignores variations that arise from different geological endowments because it assumes, implicitly or explicitly, that oil necessarily generates high rents (for instance, Ross 2012) or because it claims that geology does not matter to key institutions of the resource sector (Luong and Weinthal 2010). Moreover, the old assumption that the resource sector has no learning by doing, such as is implied by “Dutch Disease” models (e.g. Sachs and Warner 1995, which builds on Matsuyama 1992), or lacks potential for backward industrial linkages persisted in the literature and in policy circles.

I identify two major gaps in the resource-curse literature: first, it lacks a conceptualization of how rents can be captured or created; second, it ignores the industry structure and its capital and technological demands. If rents are critical to understand how resource wealth will affect political actors, geology has to be taken into account since different endowments will result in varying levels of rent availability and technical challenges. Whereas conventional oil generates high rents (because of its lower cost of production) and can be produced with off-the-shelf technologies, unconventional resources are more expensive and trigger more demand for technological solutions, capital and operational investments, and skilled personnel. Those reasons justify a closer look at the sources of rents and how geological factors may affect their availability.

Furthermore, oil production from high-cost sources is done by a multifaceted industry, with many suppliers using high-skilled personnel operating advanced machinery. Such an O&G industry has a complex value chain that starts even before a well is drilled, is globalized and modular, and provides possibilities for large industrial linkages with the rest of the economy and industrial policies. I will present next how value is generated in the oil industry and where the rents are most abundant. This will be followed by an analysis of the different sources of rents and their political significance and incentives to the stakeholders of the oil sector. I will connect geology, industry characteristics, and political incentives to new distributive pressures and the rules of distribution of the natural resource sector.

⁷ In fact, Ross (2012) and Andersen and Ross (2014) argue that the curse is a post-1970s phenomenon, when oil-rich countries renegotiated contracts with International Oil Companies (IOCs) or nationalized their resources, allowing them to dramatically capture more rents for their coffers.

3. The industry value chain and the role of states

The O&G industry is one of the most important and complex of the world (Inkpen and Moffett 2011). It annually invests more than \$300 billion only in the exploration and production (E&P) segment, it is the biggest consumer of steel of all industries (Bret-Rouzaut and Favennec 2011), and the most important commodity in terms of value, corresponding to 4.8 percent of the global GDP in 2013 (Aguilera and Radetzki 2016). Such a complex industry has a long value chain that is divided into upstream, midstream, and downstream. However, it is in the upstream (E&P activities) that most of the rents in O&G are found (Tordo et al. 2011) and the focus of this study.⁸

Countries typically have ownership of the subsoil rights and the power to determine the conditions under which companies (or a state monopoly) can operate. The total share of revenues kept by the state is called government take and it can go as high as 98% in some countries (GAO 2007, Van Meurs 2008). After the acquisition of exploratory rights from a state, an oil company will gradually invest in activities that reduce the uncertainty about whether a commercial discovery can be made. Projects in the upstream can easily cost billions of dollars, particularly for deep offshore, and a company can take up to a decade and invest hundreds of millions of dollars before starting to receive revenues from the oil production.

The oil industry is considered to be special in economic terms because firms can have radically different cost structures, such as 20 times more than a competitor, and still compete in the same market (Pinto Júnior et al. 2007). Access to reserves is critical in understanding how this can occur. Economic theory expects production to continue until marginal cost equals price. However, in the oil business, given government ownership of resources, areas with very low cost of production can cut back their output or limit the investment in productive capacity in order to receive more from each unit sold – as members of the Organization of the Petroleum Export Countries (OPEC) try to do. The consequence is that areas with higher costs in the world are developed before low-cost areas from OPEC countries are depleted.⁹ The need to venture into geologically challenging areas and comply with new regulations (such as environmental standards and local content requirements) has led to an increase in the total capital and skills requirements of the industry. Typically, costs of services and equipment in this industry follow closely the price of oil (see Figure 2.1), as higher prices increase the demand for E&P activities in areas that at low prices are not commercially viable (marginal fields or frontier areas). Reserves from

⁸ See the appendix for a more detailed analysis of the O&G value chain.

⁹ Although within each country low-cost areas tend to be developed first.

deep offshore, tar sands and shale oil are taking the place that used to belong to low-cost onshore oil. As production goes from good ore to bad and from bad to worse, more ingenuity is needed to locate new reserves and economically produce from them. As put by the energy economist M.A. Adelman, additional reserves “were no gift of nature. They were a growth of knowledge, paid for by heavy investment” (Adelman 1995, p. 17).

In addition to resource-owners (countries) and oil operators (NOCs and IOCs), oilfield service companies are another important player in the industry. Those companies grew by filling niches left by oil operators (outsourcing) and by working in partnership with NOCs that had access to resources but lacked expertise in developing them. The importance of oilfield service companies is evident from the fact that 70% to 95% of all expenditures made by oil companies in the upstream segment are outsourced (Bain & Company and Tozzini Freire 2009, Raymond and Leffler 2006). A common characteristic of the main oilfield service companies is the large share of revenues dedicated to R&D, which can go above US\$1 billion a year (Economist 2012).

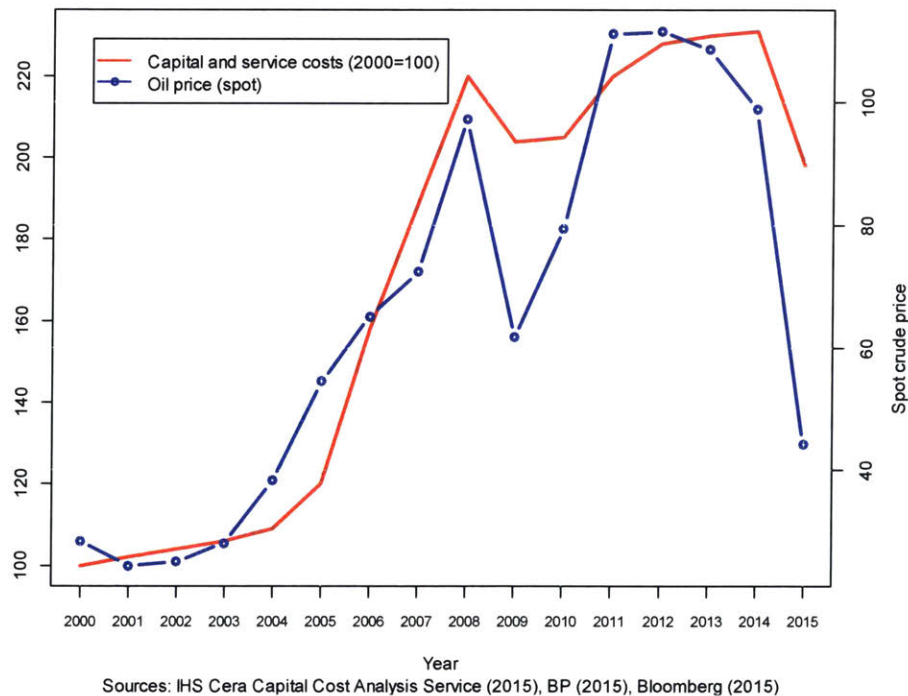


Figure 2.1: Cost of equipment, facilities, materials and personnel in the upstream

This qualitative change of how oil is produced – with a growing share of unconventional and technology-intensive methods of production – is likely to accelerate (Aguilera and Radetzki 2016). For

unconventional resources, government rents are lower, but there is a greater potential to locally provide part of the goods used in the production, such as drilling ships and platforms, and technological solutions. These differences that originate from the geology – amount of rents available and the necessary capital to produce hydrocarbons – have deep political and economic consequences. They induce different strategies on how to deal with oil abundance, starting with how a state and its political class manage to capture or create rents.

4. From rent capture to rent creation

Availability of rents is the key mechanism of political economy explanations of the resource-curse. This section reviews the different types of rents and shows that one of them – Schumpeterian or innovation rents – induces different political incentives for resource-owners, an aspect until now neglected by previous studies and key to understanding under what conditions natural resource abundance can be important for domestic industrial demand and R&D activities.

Rents are described as “payments made to a factor of production that are in excess of what is required to elicit the supply of that factor” (Stiglitz 1993). Three types of rents have been commonly applied to understand the oil sector: scarcity, differential (or Ricardian), and monopolistic. Exemplifying them, hydrocarbons are a scarce commodity, their production costs can vary from country to country, and OPEC oil exporters attempt to restrict output to increase prices. Those source of rents, and strategies to maximize their capture, are commonly addressed in the literature on development and natural resources (e.g., Fattouh and Mahadeva 2013, Gillis et al. 1992, Mommer 2002, Stiglitz 2007, Yergin 1991). In comparison, entrepreneurial or Schumpeterian rent originates from innovations in the productive process that allow a company to have higher returns than its competitors. This can come from efficiency gains (cost reduction) or the supply of a different and superior good during the process of creative destruction. The production of an old commodity such as petroleum in a new way, for example by deploying advanced technology, fits Schumpeter’s definition of innovation (Schumpeter 1942, p. 132), although the resource curse literature traditionally neglects the role of the oil industry as a source of innovation. Table 2.1 summarizes the different types of rents and their sources.

Table 2.1: Varieties of rents

Rent type	Source
Scarcity	Inelastic supply of a commodity
Differential	Differences on cost of production between alternative firms/countries
Monopoly	Use of a dominant market position to raise consumer prices
Schumpeterian/Entrepreneurial	Introduction of an innovative product or process

Source: Author's elaboration

Schumpeterian rents have become highly important to the oil industry because innovation is bringing new sources of oil to the market. First, crude oil can be produced from a variety of geological formations with different cost structures. Second, given the large difference of capital expenditures (CAPEX) and operational expenditures (OPEX) of different producing regions, there is a large payoff for solutions that reduce the cost required to produce a barrel of oil coming from high-cost areas. Table 2.2, from the International Energy Agency (IEA 2015), provides a sample of different expansion projects and their required costs.

Table 2.2: Estimated oil development and production costs

Country or region	Type of project	Capital cost per barrel per day of capacity (\$)	Operating costs (\$)
Iran	Onshore expansion	12-17	3-5
Iran	Onshore giant	20-31	5-7
Brazil	Deepwater pre-salt	38-65	12-16
Canada	Canadian oil sands with upgrading	95-114	25-30
Iraq	Onshore super-giant	9-14	2-5
Kazakhstan	North Caspian offshore	67-76	15-20
Saudi Arabia	Onshore generic expansion	9-14	2-5
United States	Light tight oil	59-90	8
West Africa	Deepwater	60-75	18-25

Source: IEA World Oil Report 2015

Unit costs, or per barrel costs, are calculated as $\frac{CAPEX+OPEX}{Production}$ and are given in dollars per barrel (Jahn et al. 2008). The data shows that the lowest cost producers (Saudi Arabia, Iran and Iraq) can add output with substantially lower unit costs than producers that are developing in deepwater, oil sands, and tight oil formations. This spread will affect the payoff of developing technological solutions that can be applied in different areas. Furthermore, cost-reduction in frontier areas may represent make-or-

break factors, as price swings may turn the whole investment unprofitable, while for low-cost producers it will only mean a reduction of differential rents.

The analysis presented so far allows us to derive clear expectations of the incentives that policymakers of countries with different resource endowments, and ability to exploit different types of rents, will have. A government of a country that has abundant, easily accessible resources with low cost will have the most to gain, in monetary terms, by maximizing rent capture: taxing the O&G sector highly and if possible coordinating to restrict output.¹⁰ At the other extreme, a country that is just marginally profitable in the production of such natural resource will have no rent to extract – high taxes cannot be charged or production will cost more than sales price. In addition, such marginal producer has no market power to influence world prices (no monopoly rents).

In the situation described above, what options are left to the less well-endowed country? Considering that geology is given by nature and the production of such a country cannot influence prices, and therefore both geology and prices are exogenous to domestic actors, the only variables that can partially be influenced by public policy are technology, tax levels and institutions that can reduce production costs and mitigate investment risks. A nation abundant with a resource that has high cost of production, rather than striving to capture rents, will first have an incentive to create rents through R&D, innovation and complementary investments, with rules and institutional complementarities that support innovation, reduce expropriation risks and allow for intertemporal transactions.

A thorough consideration of how different geological challenges interact with investment decisions by oil companies shall start from the perspective of the firm, which will be done next. This will lay the basis of an analysis of the incentives and constraints faced by policymakers in the different scenarios considered. Those incentives will be critical to understand the process of creation and evolution of the rules of distribution of the resource sector.

Rules of distribution, institutional complementarities and investment decision

To understand the relationship between geological challenges and the rules of distribution of the natural resource sector and institutional complementarities, it is worth noting that oil production is

¹⁰ It is worth noting that OPEC balances a strategy of rent-maximization for its members while limiting the incentives for oil substitution policies of consumer countries that a long-term very high-price strategy would induce.

influenced by below- and above-ground factors. Below-ground challenges will be more demanding of above-ground solutions to facilitate extraction. As a result, a challenging resource base will increase the returns for investing in rules and institutional complementarities that can support its development. While investment decisions of NOCs take into account factors beyond economic return, I claim that the high capital requirements of unconventional production force NOCs closer to rational calculation, particularly because many projects (such as in deep offshore) are done in partnership with private oil firms.

Before any drop of oil can be produced, a firm has to overcome exploratory and commercial risks. Investment decisions on exploratory programs involve a cost-benefit analysis that has the following probabilistic approach (Bhattacharyya 2011):

$$EMV = P \times NPV - E,$$

where EMV is the expected monetary value, P is the probability of a successful discovery or the expected ratio of non-dry wells to the total number of wells drilled, NPV is the net present value of developing the field, and E is the exploration costs. Consequently, high geological risk and the costs of the exploratory activity itself decrease investment in exploration, while the size of a hypothetical discovery, the expected oil price, and the tax regime will affect the NPV.

In addition to these inherent risks, exploration may be hindered by contractual disputes. As a firm makes high fixed investments necessary for production, the bargaining power shifts to the host government, which can act opportunistically by unilaterally renegotiating the terms of the contract after the investment is made, a situation that Vernon (1971) called the obsolescence bargain. Investments that are asset specific and have long lead time are more vulnerable to such opportunistic changes. Asset specificity means that investments cannot be deployed elsewhere without losing considerable value, while lead time refers to the length of time elapsed between the start of the project and when it is completed. A longer lead time exposes a firm to more political changes, which can be very risky in sectors that are highly regulated.¹¹ As a result, investments that are asset specific and have longer lead

¹¹ A characteristic of the oil industry is that, in the majority of cases, the average cost of a barrel will be much higher than the marginal cost (Clô 2000). Once a large investment to produce oil is made it becomes a sunk cost and decisions to continue producing or not will be determined by the marginal cost of a barrel. Consequently, even when firms face unilateral tax increases, they will still have a strong incentive to continue producing.

times will be more demanding of solutions that facilitate intertemporal transactions in order to secure the initial profitability of the project.¹²

Firms also need to structure how to finance their investment requirements, recruit and train their human capital needs, and solve technological challenges. The strategies used by firms and possibilities for capability building will be influenced by a country's "soft infrastructure" – its institutions, regulations, social capital, and value systems (Lin 2012). As analyzed by Hall and Soskice (2001), the political economy institutions of a country interact with firm strategies, affecting their behavior. This institutional complementarity framework is helpful to understand how institutions and firm behavior co-evolve and can reinforce each other, particularly for a sector that has close ties with the state and direct production through NOCs. These aspects will be particularly important in places with complex geologies, which require complementary investments and involve alternative development plans, where the easier route of short-term production maximization results in lower overall resource recovery, while maximization of long-term recovery potential might require adjusting fiscal terms and additional investments in capital goods and technology.

Starting from the investment decision-rule of an oil firm and the technical aspects of the industry previously presented, I will proceed by analyzing how different types of geological plays interact with government decisions and institutional complementarities in shaping firm behavior.

Low-cost, conventional oil from traditional producers

The majority of the world's reserves are in countries that belong to the OPEC and their production is mostly from traditional, low-cost wells (Aguilera 2014).¹³ OPEC countries, particularly those from Middle East and North Africa (MENA), have the lowest cost to find, develop, and produce oil in the world. This is so because of the dominance of giant fields¹⁴, which require less investment per unit of output, meaning that less drilling and investment in facilities are necessary. Giant fields are easier to

¹² More generally, Knight (1921) had already observed that the longer the production process is, the more uncertainty will be involved, thus the importance of the devices that emerged to deal with this phenomena, such as insurance.

¹³ OPEC is composed of Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. Of these, Nigeria and Angola have, in recent years, a significant growth of deep offshore oil production and Venezuela has sizable reserves of extra-heavy crude that is also difficult to extract. Still, the lowest cost of production can be found in Middle East OPEC countries followed closely by OPEC countries outside the Middle East.

¹⁴ A giant field is a field that has more than 500 million barrels of oil equivalent of recoverable resources.

find (or harder to miss), resulting in lower E&P costs. Fewer wells are drilled and those that are tend to strike more oil.¹⁵ Average drilling success rate in MENA countries are 65%, in comparison to 40% worldwide (IEA 2005) and just 15% in the Gulf of Mexico (Sener 2008).

Furthermore, most fields in MENA countries are located onshore or on shallow waters, which are cheaper to develop than deep offshore. The overall geology of the Middle East is favorable in terms of reservoirs with higher porosity and permeability and shallower depths. Finally, the Persian Gulf, where offshore production takes place, has a maximum of 300 meters of water depth, allowing E&P from cheaper rigs and fixed platforms (IEA 2005, p.135). Depletion rates are also lower, meaning that the same fixed investment can be spread over a larger amount of time. These technically simpler fields can be operated by NOCs that do not have to invest important sums in technological development. In addition, partnerships with IOCs and oilfield service providers are facilitated through high rates of returns and short lead times – extraordinary NPV. With the lowest cost of production and investment in the world, OPEC countries are certain that regardless of the foreseeable oil prices, they are in the oil business with the most competitive price in the world.

Summarizing, conventional oil producers have low exploratory risks, high NPV, and low capital costs in exploration. All combined, OPEC countries and others that share similar geological characteristics can concentrate on rent-capture and still produce oil, being prey to all the maladies associated with high rents that accrue to the state coffers.

Deep offshore/frontier areas

As conventional onshore prospects became depleted or out of reach of the IOCs, oil companies started to venture more into the exploration in the sea. The pioneer area of intense development was the US Gulf of Mexico (Pratt et al. 1997), which has low taxes in comparison to the rest of the world and easy availability of access to leases, infrastructure, capital goods and skills (GAO 2007, Priest 2007). In the 1970s, Norway and the UK explored the North Sea, and through discretionary license policies and favorable tax rates helped developing an innovative industry linked to offshore oil production as well. Deep (> 400m) and especially ultra-deep (>1500m) offshore are the next frontier of production.

¹⁵ For example, Tsui (2011) references that the United States drilled 414,979 wildcats to locate the same amount of oil that required only 168 wildcats in Saudi Arabia.

Yet finding and producing O&G at these depths are challenging. Exploratory risks are higher, with an average 30% success rate, meaning that most wells will be dry and each attempt alone could cost about \$100 million. For this reason, it is common for oil companies to pool together resources in consortiums investing in new exploratory blocks. Deep offshore projects tend to be too risky, costly, and complex to be managed and paid for by a single company (Jahn et al. 2008, Raymond and Leffler 2006). The segment is extremely capital intensive – CAPEX can easily go over the billion dollar mark in commissioning drilling rigs and the future production of platforms for a single project. Many of the inputs are sourced globally but since outsourcing in this segment is very high – up to 95% – many activities can be localized in the host country. This is a sector of intensive development and different technological solutions to increase NPV are constantly tried (Leffler et al. 2011, Lloyd’s 2014).

Offshore wells tend to be highly productive, but at the cost of a faster reservoir decline rate.¹⁶ Therefore, much higher capital expenditures have to be incurred to produce for a shorter time span. From the viewpoint of a government, high depletion rates mean that it has to continuously attract or directly invest in new productive capacity to replace diminishing production from existing wells. Concluding, production of oil from deep offshore has several characteristics that are unlike conventional oil: exploration is riskier (low P), E&P costs are significantly higher (high E), and depletion is faster than traditional giant-fields (affecting the NPV). In addition, lead-times are much higher, taking up to a decade from land acquisition to start of operation, making those investments more exposed to political cycles and price fluctuations (including of goods and services).

Shale gas, tight oil and oil sands

Oil sands and shale oil are the latest sources of unconventional oil.¹⁷ Oil sands are deposits of bitumen, a very viscous oil that requires additional energy-intensive processes to allow the resource to flow and refine. They can be mined or recovered *in situ* and only Canada has sizable production of these resources at the time of writing. Shale gas and tight oil refers to deposits of hydrocarbons found in shale formations, where permeability is very low. These are hydrocarbon-rich formations that, if subject to conventional extraction methods, yield low, not commercial, recovery rates. However, with the advent

¹⁶ While the decline of production of a Middle East field is less than 3% a year (Bret-Rouzaut and Favennec 2011), in offshore areas like the North Sea it can be 13.5% (Adelman 1993).

¹⁷ There is no standard for defining unconventional oil. Deep offshore was considered to be a source of unconventional oil due to its complexity of extraction, although the properties of the oil itself are conventional.

of horizontal drilling and hydraulic fracturing, it is possible to extract more O&G from these formations, thus making them commercial reserves in some plays. Decline rates of shale gas and tight oil are among the fastest in the industry – 50% of the total recoverable oil is extracted in the first year and 80% in the first three years (IEA 2015). The result is that the activity is drilling-intensive. To keep up production, firms have to continuously drill, which bring costs up.

Although current production of O&G from shale is mostly confined to the US, global technically recoverable resources are estimated to be high: 335 billion barrels of oil and 7,299 trillion cubic feet of gas (EIA 2013). This includes diverse countries like Argentina, Australia, China, Mexico, South Africa and Russia. Production was pioneered in the U.S., jump started by the entrepreneurial spirit of many different companies and the fact that private ownership of subsoil rights facilitates experimentation and bargaining between landowners and operators (Zuckerman 2013). Production in the US had grown spectacularly, going from just 6% of total supply of natural gas in 2005 to 50% in 2014 (IEA 2015, p. 84) and it depends on technology learning and efficiency improvements to stay cost competitive.

Despite different geological properties, production of O&G from shale and oil sands are both very cost intensive operations. Lead times for shale are particularly short. This means that shale plays can more quickly react to price swings: firms can stop new drillings once margins become negative or restart them as the price becomes favorable (Espinasa 2016). Tar sands and shale tend to have low to medium exploratory risk (P), very high investment in E&P (E), and low NPV. Of all current forms of O&G production, they are the most marginal in the sense that they are more exposed to price fluctuations. On the other hand, shale has short lead times, being able to put into production much faster than offshore operations and consequently being less exposed to the obsolescing bargain (Vernon 1971).

Table 2.3 summarizes the main economic characteristics of the different resources.

Table 2.3: Economic characteristics

Predominant geology	Exploratory risk	Investment intensity	Lead time	Rents per barrel
Onshore/shallow waters from traditional producers	Low	Low CAPEX and OPEX	Short (2-3 years)	High
Deep offshore/frontier areas	High	High CAPEX and OPEX	High (7-10 years)	Medium to Low
Shale O&G	Low	High CAPEX and moderate OPEX	Short (2 years)	Low

Source: Author's elaboration

From geological endowments to political incentives

Given the above considerations, we can derive the political consequences of developing different geological endowments. Abundance of conventional oil deposits generates high rents and demands very little in terms of capabilities of oil companies and institutional complementarities, freeing governments to focus on strategies of rent-capture. Government can prioritize the fiscal returns from the oil sector and production can be sustained at high levels, even when companies are inefficient and the government take is high. Demand for capital goods and skilled personnel will be low, per unit of output, thus reinforcing the fiscal component of the natural resource sector over other potential impacts, such as investment in R&D and in supply chain development. This pattern conforms to the image of the oil industry as an enclave that has few linkages to the rest of the economy other than fiscal revenues. According to this view, “Oil and gas extraction can occur independently of the political processes of a country” (Inkpen and Moffett 2011, p. 43), and it does not require the cooperation of the citizenry or much support from state institutions. Likewise, another common claim is that oil companies “buy relatively few inputs from local firms and thus generate few backward linkages to the local economy” (Ross 2012, p.45).

On the other hand, the production of high-cost oil will be facilitated by rules that secure the stability of investments against expropriations, including the public perception of fair contracting between oil companies and the state (Stiglitz 2007); adjust the government take to the business risks and allow for risk-sharing of projects between different companies (Jahn et al. 2008); provide a stable business environment and well-staffed regulatory apparatus (Johnston 2003); and support an innovation ecosystem that facilitates investment in public goods such as human capital and R&D (Morais 2013). High-cost oil is technology intensive and can generate many supply opportunities, as highlighted by the experiences of offshore oil in countries as diverse as the UK and Norway in the North Sea, the US in the Gulf of Mexico, or developing countries such as Brazil, and Malaysia.

Those distinct geological endowments – the volume of reserves and their cost of development – and associated industry characteristics create incentives for political actors who are involved in setting the rules of the natural resource sector. The executive branch, as manager of national resources, is the first affected by these incentives, and I expect that rule creation (or reform) will be initiated by the

executive. However, the executive faces political constraints that can be either distributive pressures, or veto points from the legislative action (Krehbiel 1998, Tsebelis 1995), or both.¹⁸

Figure 2.2 conceptualizes how a key component of a country’s geological endowments, extraction costs, can influence the rules of distribution of the resource sector – the rules that define who can extract, under what regulations and tax level, and who benefits from the activity (localization policies). The volume of resources and its associated extraction costs provide direct incentives for the executive, which is interested in the economic results from hydrocarbon production. However, for such production to be started and sustained, extraction costs have to be below the market price for oil. Extraction costs also affect interest groups by shaping their distributive demands and expectations about future costs from the extractive activity and potential benefits. The rules of distribution adopted will be the result of a winning coalition that arises from the bargaining between the interest of the executive, parties and pressures from interest groups. The dashed line depicts the dynamic effect from the rules of distribution to extraction costs: in subsequent periods, a country’s rules on access to resources, government take and investments in local suppliers and research organizations will also have an effect in the knowledge about its resource endowments by stimulating (or not) prospective investments and cost reduction.

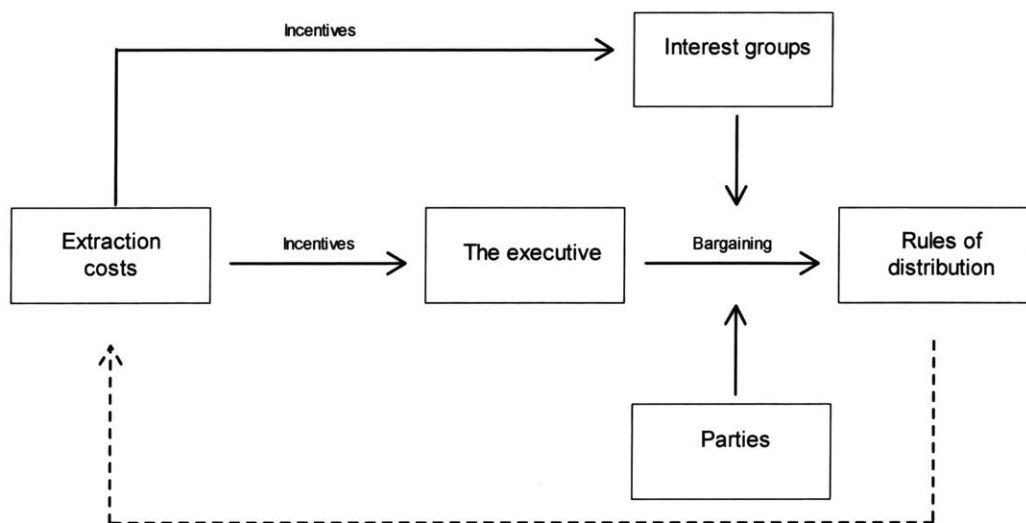


Figure 2.2: Dynamic pathways from extraction costs to rules of distribution

¹⁸ For instance, a coalition that is concerned about environmental impacts from unconventional oil production and is powerful enough to serve as a veto point can block production of this source of oil.

From the industry characteristics and the analytical model presented above, it is possible to predict that under high-cost oil, where the demand for capital goods and services is higher, it is likely that pressures to include local suppliers in the production chain in the form of local content mandates will increase. Those mandates are not, in any way, necessary for the development of high-cost oil, and they may even be detrimental to it in terms of time and cost overrun. However, I expect it to arise due to the political benefits that such policy can confer to firms and lawmakers. Given the need to minimize inefficiency costs from the enactment of local content, and the fact that the executive wants to secure oil rents, I expect the adoption of such mandates to be followed by industrial policies that aim to coordinate investment and build capabilities – institutional complementarities that are important for developing high-cost oil.

While the pressure for local content is related to the absolute amount of capital costs per barrel, the market disciplining effect of extracting predominantly from a low-margin, unconventional source, will be less intense under periods of high oil prices because of the soft-budget constraint effect. Nonetheless, such effect will be less intense due to the lower availability of rents per barrel (in comparison to conventional producers) and the need for quicker adjustments during cycles of low oil prices in order to bring costs down. Therefore, in the long run, I expect oil companies (including NOCs) that predominantly operate high-cost oil assets to be more innovative and efficient to stay in business competing with firms that extract from conventional oil, with possible deviations during high oil price cycles.

To sum up, resource endowments vary in their characteristics, rents per unit of output, and what it takes to extract them. All these generate political incentives on how to structure the rules of the resource sector. Where natural resources are abundant and easy to extract, there will be little incentive to improve the efficiency of production or invest in technology or the supply chain. On the other hand, where resources exist but rents are few, an arrangement to support rent-creation will facilitate the development of the natural resource sector. However, such arrangement requires an alignment of political incentives to be enacted, and local content may serve as an inducement for policymakers. In the sequence, I explore the components of a rent-creation cycle and in the next section, I provide a theory to account how oil firms will respond to LC mandates.

The technological cycle of rent-creation

Technology has long been recognized as a central driver of growth (Feige 2015, Gancia and Zilibotti 2005), and policymakers frequently voice their desire to promote sectors which are technology-intensive. As previously addressed, natural resources have not been considered a “high-tech” sector by policymakers and practitioners, but this view is in contradiction with a closer look at the industry structure and its capacity to build linkages with the rest of the host economy. In the case of high-cost resources, a set of rules and institutional complementarities has to be in place in order to promote and sustain a natural resource sector which is not “naturally” competitive – but which can become so after sustained investments in technological gains and cost-reduction. Three important components of the technological cycle of rent-creation shall be highlighted: 1) promoting innovation to enable frontier areas and cost reduction; 2) supporting extraction through adjustment of government take and sharing costs such as human capital formation; and 3) increasing absorptive capacity of domestic companies in order to capture more of the industry value chain.

The state participates in the rent-creation cycle by the way it spends resources (such as in R&D and human capital formation), regulates the conditions of entry of the industry into E&P and takes part in the coordination of activities related to the O&G sector. In doing so it creates and reinforces institutions associated with the knowledge and productive process (e.g., research centers, regulatory and investment promotion agencies, business-government councils) that supports the development of the oil sector and its cluster of companies. The production challenge creates incentives for upgrading the state agencies that govern the sector, where they already exist in a state with strong and more evenly distributed capacity, or to have them stand out as a “pocket of efficiency” with meritocratic staffing and capacity to dialogue with the industry in order to identify bottlenecks and solve constraints.

The technological aspect of this cycle is an innovation system¹⁹ around the resource sector that promotes collaborations between oil companies, suppliers and research institutions in developing solutions that enable new production and reduce costs. These are opportunity-creating innovation policies, as defined by Edquist et al. (2004), which can rely on a set of instruments (e.g., public procurement of technologies, basic R&D funding, creation of supporting institutions) that facilitates innovation and serves as a “midwife” of new technology fields and production sectors.

¹⁹ As defined by Freeman (1987, p. 1), an innovation system is “the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies.”

Ville and Wicken (2012) provide a framework of resource-based economic development that is applied to explain the successes of Australia and Norway. In their analytical model, resource industries work in close collaboration with enabling sectors (capital goods, business services, R&D and ICT) developing solutions that allow for the further expansion and transformation of the resource-based industries. Contrary to the standard assumptions of resource curse theorists which see no learning or spillovers occurring, the natural resource sector worked as a driver of knowledge development in other areas of the Australian and Norwegian economies. In their view, while the environment is given, “natural resources are the outcome of socio-economic processes where the environment is transformed into economic resource” (Ville and Wicken 2012, p. 1352).

The opportunities brought by the natural resource sector can be confined to a few companies – an enclave is an example of an extremely confined case – or encompass different firms and sectors. The absorptive capacity of domestic firms is a necessary condition to broaden the demand of the natural resource sector to more firms and to generate spillovers across the economy – as studies of how foreign direct investments (FDI) can generate spillovers have pointed out (Farole and Winkler 2014, Paus and Gallagher 2008). In these works, industry-specific characteristics, local capacity to embed with the supply chain of foreign investors, and country-level economic and political institutions interact to explain the amount of spillovers that can be generated. Among the most important factors are the technological intensity of the industry (which for high-cost oil is high) and sourcing strategies (which can be influenced by regulatory policies, such as LC requirements). Industries that produce goods that are intensive in technology and R&D have high requirements for skills and knowledge, showing more potential for positive spillovers. This sophisticated demand, if sourced locally, pressures firms for better and more diverse inputs. Multinationals may also engage in direct assistance and help local producers to upgrade their capabilities. Local sourcing becomes a key channel through which higher requirements derived from technically sophisticated industries diffuse in the host economy. Hence, a higher level of embeddedness leads to more spillover effects, with firms benefitting from “learning-by-supplying.”

Absorptive capacity is necessary but sometimes not sufficient because domestic companies may be capable but not demanded if foreign firms prefer to restrict their procurement of goods and services to suppliers with which they already have a relationship in other countries. In such situations, policies that nudge lead firms to procure domestically or upgrade local suppliers, such as LC policies, can maximize the benefits and allow capturing a higher share of the value chain. For this process to work,

regulations have to be credible and a coherent productive policy needs to be in place for supporting domestic firms to reach international quality standards and competitiveness.

Government activism to support the development of oil operators is far from being exclusive of more “coordinated market economies” like Norway, but are also observed in the historical development of the oil industry in the liberal economies of the U.S. and the UK. As the importance of domestic oil companies and their suppliers to the economy grew, so did their lobby power. In the US, the development of the Gulf of Mexico had the active participation of the state in supporting higher-cost producers through politics and policies that assisted and encouraged oil output. Those policies included limitations on imported oil, easy access to tracts of land for exploration by oil companies in Federal waters, reduced government take to stimulate purchases of deep water exploratory acreage, and tax incentives for research. Overall, the US policies for the Gulf of Mexico aimed at promoting the development of the area and the required technologies rather than maximizing government revenue (Priest 2007). Hugues (2014) shows how oil business demands to the government in the US were shaped by that country’s initial resource endowment. While both small and big firms focused on using the resources of the government to improve their commercial position, large firms diversified their operations and started to produce from cheaper reservoirs in the Middle East. Small firms, domestically focused, faced increasing competition from imported oil from cheaper oil fields. They lobbied directly for protection and policymakers were sympathetic to them in part due to the jobs that the oil industry generated in their home districts. In contrast to Japan and France, resource-poor nations which Hugues (2014) also studies, the existence of large factor endowments in the United States allowed smaller producers to remain a powerful political force in shaping oil market governance. It was also smaller firms that invested in technologies for unconventional oil production (fracking and horizontal drilling) which ultimately unlocked a new era of resource abundance in the US (Espinasa 2016, Zuckerman 2013).

Likewise, the UK and Norway supported their industry through localization policies (such as “Buy British” and Norwegian local content), investment in human resources for the sector and, particularly in Norway, extensive use of policies to promote innovation and industrial capacity for the offshore oil industry (Hatakenaka et al. 2006, Ryggvik 2014). As Am and Heiberg (2014) analyze, the Norwegian experience in O&G show how resource optimization demanded capabilities from oil companies *and* the state. Not only the state worked to de-risk investments by building an environment of trust and cooperation, but it also participated in public-private partnerships for R&D, education, and supply chain development (Am and Heiberg 2014). The UK adopted a very flexible approach regarding government

take, reducing taxes in order to maximize production and guarantee the continuous operation of platforms when their reserves started to decline and costs per barrel increased (Mommer 2002). The result was a strong business and academic environment that rely on and support the growth of the natural resource sector – along with constituencies that politically support the growth of the industry.

In the empirical chapters about high-cost oil producers in this study, Brazil and Malaysia, we observe this sequence: it starts with high capital and technological demand from the main firms in the natural resource-sector, and leads to supplier integration and development along with investments in human capital, frequently aided by state policies. This work thus extends to developing countries models that postulate the role of resource abundance to development and capability building, frequently focused on the experience of Norway (Am and Heiberg 2014, Hatakenaka et al. 2006, Ville and Wicken 2012), and qualify them by identifying the importance of high-cost of production of natural resources to the generation of spillovers and policies that maximize backward linkages.

All components of the rent-creation cycle have important political implications for the way the state prioritizes the allocation of resources, organizes state agencies, and structures the productive links between oil operators, knowledge institutions, and the domestic supply chain. However, the particular connection between oil operators and the supply chain is the one which has the most political significance: it gives rise to a new type of industrial policy and a new distributive conflict which are the politics of LC.

5. The politics of local content

In the previous sections, I showed that high-cost O&G has high demand for capital and operational expenditures and for technological innovations. Governments that are resource-owners of marginally competitive O&G deposits, have the incentive to support the industry in order to enable production and reduce their cost. Investments in innovation and human capital are part of the toolkit to create Schumpeterian rents in the resource sector. I also argued that the combination of government resource ownership with high development cost increases the returns for the business sector to attempt to influence procurement policies of oil companies – lobby for LC mandates. This has a two-fold consequence. From the point of view of the oil firms, this means that they have to engage more extensively in searching for domestic suppliers and work with them building capabilities. From the point of view of domestic companies and business associations, there is a continuous incentive to lobby for

regulatory changes to broaden the number of equipment and services that are benefitted by the protective regulations.

This brings conflicting incentives that have distributive and political implications. On the one hand, a very inclusive LC policy will raise production costs by forcing more inefficient companies in the set of preferential suppliers. This can drive production costs beyond the maximum that is profitable for oil companies, meaning that output levels will be penalized. On the other hand, granting preferential treatment to a broader set of firms can bring political payoffs to those in power.²⁰ Whether or not LC policies are tools of a new petro-developmental state, as Ovadia (2016a) argues, is an open possibility, but regardless of their long-term achievements, they are definitely tools for coalition-building as they can bring short-run political benefits. Because of the highly regulated nature of O&G production, it becomes a political decision where capital goods like oil platforms, drilling rigs, and supply vessels will come from and the citizenship of their operators and management, which can lead to a dynamic that I call contract-seeking. The higher the costs of oil production in relation to its selling price, the more money will be exchanged in the form of contracts than in government rents. For example, if in a given country it takes \$45 to produce a barrel of oil and the international selling price is \$50, a \$5 rent will be split between the oil company and the government, but the \$45 will be spent on domestic and international suppliers. How much of that share of domestic over imported content will be fixed in regulations is a source of political disputes between politicians, oil companies, and suppliers – and will also affect local employment and tax generation levels.

Any LC requirement, at whichever level is set, imposes initial costs in terms of management and efficiency to oil companies.²¹ A company that operates in a country with a LC requirement in O&G, in addition to looking for oil, has to look after suppliers. LC policies require that oil operators have to purchase a significant share of their capital goods and services from local suppliers, many of them still catching up with internationally competitive providers. Any delays from those new suppliers can affect the rate of production of oil operators, or first oil (Jahn et al. 2008), and thus the cash flow of projects. This gives oil companies a strong incentive to interact with local manufacturers up to the point of transferring technology and managerial skills – effectively looking after their development. The

²⁰ Such political rewards can come in various forms, such as credit claim for jobs generated in the O&G chain, legal political donations from companies benefitted by the policy or illegal benefits such as bribes.

²¹ Even if it is set at a level where the oil company would already buy from domestic suppliers, there will be compliance costs with the regulatory paperwork. However, the typical scenario is to set the requirement beyond the market-clearing price; otherwise there would not be a need of regulations to change the behavior of firms.

difference of contract-seeking to pure rent-seeking is the uncertainty derived from the productive challenges involved in upgrading domestic capacities of the latter and the fact that oil operators have strong incentives to reduce any rent transfer to suppliers.

This relationship between oil companies and suppliers, mediated by government policies and institutions, creates a new type of industrial policy, which has strong interactions between oil companies and their suppliers and feedback mechanisms to policymakers. Although an LC policy resembles a typical import-substitution policy, it has many different components. In order to analyze the particularities of LCP, I will resort to a principal-agent framework and Hirschman's concepts from *Exit, Voice, and Loyalty* (1970).

Exit... is perhaps Hirschman's most influential work and has been extensively applied to areas beyond the author's initial analysis of consumer responses to quality decline in firms and organizations (Hirschman 1978, Dowding et al. 2000). Traditionally, economists tended to concentrate on the exit option as a signal that consumers are unhappy with a firm – where the decline of sales is an indicator that the product or service is less rewarding to consumers than it used to be. Unit sales or revenues are highly visible and easy to measure, thus quickly informing managers and owners. However, for products with inelastic demand and some organizations with which individuals are associated (by voluntary or compulsory means), exit may be excessively costly. Given the limited availability of the exit option, consumers and citizens may resort to voice – verbally expressing concerns in the expectation that the firm or organization will change its practices. It is an attempt to change rather than to escape from, and can be exercised in a variety of ways, from a simple petition to the management team to collective protests.

Both options have advantages and drawbacks. Firms may ignore voice if consumers are captive – such as in a monopolistic condition, where incentives to change are low. On the other hand, exit is a crude indicator of consumer's preferences: it does not directly communicate where the problem of the firm lies (if prices are high, if the quality has deteriorated or if some better substitute good has appeared in the market). Typically, firms resort to a combination of exit and voice indicators: the financial bottom line and surveys with consumers and market research.

Applying this concept to LC policy highlights its difference compared to other forms of industrial promotion through LC requirements, particularly the import-substitution industrialization (ISI), and more top-down industrial policy efforts. ISI development models frequently granted strong domestic

protection to firms in order to stimulate investments. Consumers were captive to domestic goods with few exit options. In such situation, particularly for the consumer goods markets, voice tends to be ineffective, as consumers face high coordination costs and the dominant position of firms in the market decrease incentives to react to consumer complaints. A closed market also reduces the repertoire of consumers – the ability to complain about inferior goods is connected to being exposed to goods of higher quality.

In contrast, the export-led development model that characterized the Asian Tigers benefited from the signals provided by consumers located in the developed markets. Firms had to compete on price (foremost, as entrants to mature markets) and quality (increasingly) to please consumers from the most sophisticated markets. A rich exchange of information between bureaucrats and industrialists facilitated the identification and solution of bottlenecks and achievements of developmental goals (Evans 1995). Voice flowed between bureaucrats and business actors, with the latter having to react to market signals coming from the exit option of consumers in the markets where they exported.

LC policies in the oil sector have an interesting combination of partial domestic exit, foreign market signals and voice. One objective of the policy is to limit exit – to increase the cost of contracting some goods outside of the domestic market. However, the exit door is semi-open. Quantitative indicators of local content requirements establish goals but allow the oil operator some room to maneuver to achieve the target. For example, a goal of spending 55% of the total cost of an oil tanker internally can be fulfilled through different combinations of inputs. In addition, legislations typically allow for goods that cannot be found in domestic markets, or only at a prohibitive cost, to be waived, thus providing an exit option for specific components.

Furthermore, an LC policy cannot insulate domestic markets from the international price fluctuation of oil. Such policy thrives where cost of production is high – where oil operators need to invest considerable amounts in capital goods and services before oil can be produced. These high-cost fields are the ones most exposed to price swings. Frontier areas become economically viable by the combination of high oil prices and technological gains, but risk being the first ones to shut down when prices swing back. Inefficiency can be sustained under a scenario of high-prices, where extraordinary future profits of oil production compensate for the costly requirements to buy from less competitive suppliers. However, as price goes down and a project for a given oil field approximates the break-even point, the risk that a future investment will not pay off rises (the NPV goes down) and oil operators will refrain from undertaking new projects. Accordingly, after the bust of the oil price that started in the end

of 2014, industry associations and analysts defended downward revisions of local content levels (Dekker et al. 2016, IBP 2015, Ovadia 2016b). As put by the International Energy Agency (IEA 2015, p. 74), LC “stand out as a policy tool that has received considerable attention in recent years but now look vulnerable to being scaled back.” The same publication recognized that LC policies were partly to blame for the capital cost increases in the recent years (as shown in Figure 2.1), but noted that companies had accepted such impositions in order to win bids for exploratory areas. This is precisely the upper hand that governments have vis-à-vis oil companies: since oil is a scarce commodity, oil companies have to seek new reserves to continue in the market and this necessarily involves reaching deals with governments. However, high levels of LC can be self-defeating if it raises the cost of developing resources to levels that turn investments unprofitable.

Holding constant the exploratory risk, the size of a potential discovery, and the discount rate, it is possible to analyze the relationship between the expected monetary value and the costs imposed by an LC policy in the following way: let e be the expected earnings, y the international price of oil, c the international costs of equipment and services and z the premium paid to fulfill the local content requirement: $e = y - (c + z)$. For e to be positive, y has to be higher than $c + z$. As the premium paid to purchase locally increases, z , the cost of developing this project becomes closer to the break-even point and enters the negative expected earnings region, thus leading to a “no-go” decision. It is clear that for the same geological characteristics, O&G fields with higher costs due to z will be avoided before similar fields operating in more competitive markets for goods and services are developed. Low oil prices affect every frontier area, but affect first the less competitive countries with LC policies.²²

Even holding constant the price of oil, the imposition of an LC policy has the economic effect of a tariff, reducing the demand for developing more costly fields. A simple way to visualize this effect is using a Harberger triangle, commonly applied to measure welfare costs of government interventions and monopolies (Harberger 1971, Hines Jr. 1999).²³ As shown in Figure 2.3, oil can be produced using imported capital goods at cost C_0 , thus generating a demand for exploring Q_0 units of oil blocks. Imposing a LC requirement increases production costs to C_1 , reducing units produced to Q_1 units. The shaded area, also known as a Harberger triangle, refers to the welfare costs of increase in production

²² E&P costs are the combination of finding costs (expenditures on exploration, development, and unproved property acquisition) and lifting costs (costs to get the oil out of the ground).

²³ But, as Tullock (1967) argues, this method produces a lower bound estimate because it does not include other costs such as resources used for government tax collection and private lobbying for protection.

expenditures – business opportunities lost due to the costs increase. In this case, these are fields which become prohibitively expensive to explore and develop due to the requirement to procure local goods.

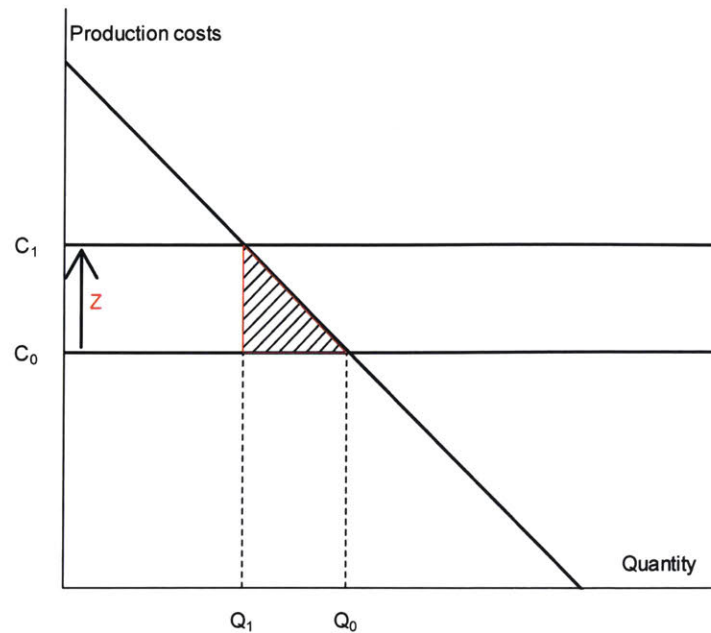


Figure 2.3: Quantity changes due to local content premium

Note that z – the cost of buying local goods – can originate from a variety of sources, such as lower worker productivity due to schooling gaps, infrastructural deficiencies that increase transportation costs, less developed financial markets, bureaucracy on doing business and pure rent-seeking of domestic entrepreneurs and politicians. On the positive side, it will also generate employment and taxes. Regardless of the origin of z , the bottom line is that the sustainability of an LC policy requires reducing the difference between local and international prices of domestic goods. The adoption of LC requirement, like a tax, has a welfare cost due to a reduction of units produced. This effect is magnified when prices go down, making investments that were once profitable become prohibitively costly and not undertaken. In such a situation, governments may support efforts of cost-reduction (including innovation), reduce tax on oil production or abandon the LC policy in order to keep the rate of investment in oil production and the associated hard currency earnings. Unlike ISI, for example, an LC policy in O&G has an automatic exogenous pressure to cost-reduction to reach similar levels of international prices for domestic goods – or abandoning the policy altogether.²⁴ This same cost-

²⁴ Which would also be a form of exit.

reduction pressure should limit rent-seeking in comparison to projects that are less exposed to international prices.

This disciplining effect rests on the probability of price changes downward, that managers will be pressured to cut costs and refrain from investing today because high-cost projects can end up being unprofitable in the future. In scenarios where oil prices are stable or increasing, it would be conceivable that such disciplining effect would be less important. However, such scenarios are improbable in the oil sector. Oil is a commodity particularly prone to price volatility and hard to predict, surpassing fluctuations of most financial markets (Hamilton 2008, Verleger 1993, Weiner 2006). In addition, there is a large lag between acquisition of an area in a bidding round and its potential development – making it much harder to commit today to develop a project that is barely profitable at current prices.²⁵ This uncertainty is well known by oil companies and LC became a new business risk variable (Almeida and Martinez-Prieto 2014).

If considerations of exit affect investment decisions, the voice aspect is present in the relationship between oil companies and domestic suppliers, and both of them and the government. Oil companies have a stake in creating capabilities that will lead to higher quality and reduced costs in its supply chain. They might well oppose an LC policy, but if accepting it is part of the conditionality of accessing oil reserves, they will have to engage with local suppliers – or avoid investing altogether. Therefore, we should expect the buildup of capabilities due to the presence of a single principal (the oil company) with high competence to monitor its local suppliers and labor force. Likewise, oil companies and suppliers will have interest in providing information to the government about competitive gaps and pressure for reforms and complementary investments that lead to cost-reduction. This flow of information can be channeled in business-government councils and is a key principle in designing effective industrial policy (Schneider 2015). Oil companies in particular are likely to pressure against the expansion of LC, but if regulations are sticky, particularly for past investment decisions, they will engage in efforts to comply with it in the most efficient way (which will include paying fines or requesting waivers when domestic costs are excessive).

²⁵ Oil majors are typically more conservative in engaging in projects that are profitable only with historically very high prices. The recent growth of unconventional resources – oil sands, shale gas and tight oil – was pioneered by smaller oil companies, which developed the more costly fields that were not under the commercial radar of the majors (Maugeri 2012, Zuckerman 2013) and by 2015 and 2016 were facing severe financial strains.

The expectations that arise from the theory presented in this section, which will be tested in the empirical chapters that follow, are that (a) the development of high-cost oil will attract pressures for LC policies; (b) such policies effectively represent a transfer of rents (from governments) or consumer (oil firm) surplus to local suppliers, the sector benefited by such policies; (c) suppliers have an interest in a comprehensive LC policy, but oil companies, and to a certain extent governments, will react if policy targets are set at levels beyond the minimal required for profitable oil production, as this will reduce total investments (and consequently oil revenues); (d) market protection is moderated by exit possibilities, such as paying fines to procure the same goods abroad, so this competitive nature is expected to limit rent transfer from oil companies to suppliers; and (e) oil companies will engage more extensively in developing local suppliers in order to reduce costs and increase local capabilities.

6. Conclusion

Hydrocarbons can be produced from a variety of sources, from conventional oil fields using standard technologies, as in Middle Eastern countries, to very deep offshore deploying subsea robotic equipment. These differences that originate from resource endowment will have economic and political consequences. Resource-owners that sit on a “favorable” geology can extract natural-resources at very low costs and accrue high rents. Others have to spend considerably more to find and produce the same commodity from more challenging reserves, with a substantive time lag between start of investment and first oil. These differences have important institutional and political consequences. In the first setting, the oil sector will develop few industrial linkages to the rest of the economy but will be very important as a provider of fiscal resources. Furthermore, oil production can be sustained without rules of distribution and institutional complementarities that allows for intertemporal transaction and building state and private capabilities to de-risk investment and maximize resource recovery. This is the traditional picture that emerges from the natural resource curse literature. In the latter scenario, a different incentive structure will be in place and the bargaining between the executive, policymakers and interest groups is more likely to lead to investments in innovation, and policies to favor the procurement of local services and capital goods, creating more industrial linkages but also politicizing investments along the supply chain. This is the new politics of oil that is the subject of this study.

The upcoming empirical chapters show that the O&G sector served political objectives and were highly relevant to understand the development strategies of the three countries studied, Mexico, Brazil

and Malaysia. Mexico is the case that most conforms to the traditional resource curse picture. It developed an inefficient NOC plagued by clientelism with very few industrial linkages to domestic suppliers or investments in R&D, but an important source of fiscal revenues to the Mexican state. However, unlike the expectations derived from previous studies (for example, Karl 1997, Mehlum et al. 2006, Robinson et al. 2006, Luong and Weinthal 2010), a changing resource base pressured for reforms that also led to new political coalitions, replacing internal stakeholders of Pemex, such as the workers' union, for business associations interested in obtaining new supply opportunities.

In Brazil and Malaysia, the evidence collected in this study shows that the technically challenging aspect of producing oil and gas in those countries both enabled and incentivized a new type of distributive and industrial policy in the natural-resource sector, politicizing supply contracts but also investing in domestic capabilities, innovation, and pockets of efficiency within the state bureaucracy. Far from the enclave image, the oil industry in those countries is deeply connected to the rest of the economy and its political pressures. This is the new politics of high-cost, unconventional oil production, which will be thoroughly analyzed in the coming empirical chapters.

Chapter 2:

Appendix: The process of reserve creation and the industry value chain²⁶

O&G deposits are the result of chemical and physical processes that took millions of years to transform organic matter into hydrocarbons. It is a nonrenewable resource in this geological time scale but it does not mean that, at any time, we know for sure how much oil is left in the ground. Estimates of available O&G depend on exploration intensity, current technologies and price.

Figure A2.1 shows production per year and proved reserves from 1980 to 2014. Production is a flow and reserve is an inventory – in the absence of new additions to the stock, the flow has to eventually stop. An important indicator used in the industry is the reserves-to-production ratio, which calculates the time it would take to deplete the total reserves given current production. By the end of 2014, the world had enough oil to sustain current levels of production for 52 years. Both production (the flow) and reserves (the stock) have been growing. Nature did not create new O&G deposits from 1980 to 2014. What changed was our knowledge of where those deposits are located and how to extract them (technology), and our willingness to give out resources to do exactly that (price). In fact, technology and price are determinants of what is called “a reserve.”

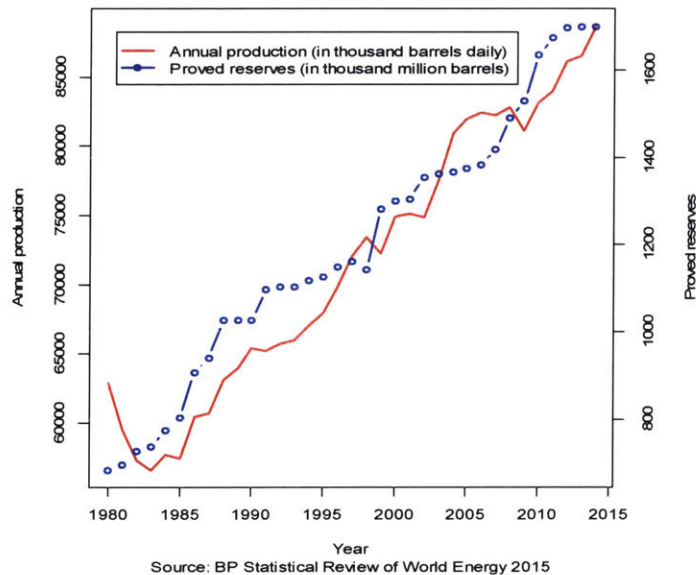


Figure A2.1: Growth of oil production and reserves

²⁶ This appendix provides complementary information about the oil industry, addressing in greater detail the process of reserve creation in oil and gas (O&G) and the industry value chain.

Reserves are classified according to the probability of producing resources given current technology and price. Proved reserves (1P) refers to resources that analysis of geologic and engineering data demonstrates, with reasonable certainty (90% or above), are recoverable under existing economic and operating conditions (EIA 2015). The calculation takes into account government regulations, including taxes and other requirements set for oil companies, since they affect the probability of actually producing the resources available. Resources that have 50% or above chance of being produced under current conditions are classified as 2P, or probable reserves. Finally, possible reserves, or 3P, have 10% or less probability of being commercially recoverable. Hydrocarbons that at current economic or technological conditions are not recoverable are classified as contingent resources. Reserve estimates thus change year to year. Even existing fields can have their reserves reevaluated in light of additional knowledge of the reservoir as production continues and new techniques of extraction and enhanced recovery are made available.

The fact that O&G production has been growing alongside total reserves does not mean that the quality of the reserves stays the same and it is a one-to-one exchange. Quite the contrary: easy, low-cost reserves are extracted first and additional ones tend to be more challenging and expensive. Reserves from deep offshore, tar sands and shale oil are taking the place that used to belong to low-cost onshore oil. As production goes from good ore to bad and from bad to worse, more ingenuity is needed to locate new reserves and economically produce from them. As put by the energy economist M.A. Adelman, these additional reserves “were no gift of nature. They were a growth of knowledge, paid for by heavy investment” (Adelman 1995, p. 17).

This qualitative change of how oil is produced is likely to continue. Despite environmental concerns on climate change and the growing presence of renewable energies, fossil fuels are still the world’s main source of energy with about 86% (BP 2015a). BP also estimates that the energy demand in the world will grow by 37% between 2013 to 2035, with the oil industry slightly reducing its share in the world energy matrix to renewables, such as wind and solar, but still growing in absolute terms.

The industry value chain

The O&G industry is one of the most important and complex of the world (Inkpen and Moffett 2011) – a point normally neglected by resource curse theorists. It annually invests more than \$300

billion only in the exploration and production (E&P) segment and it is the biggest consumer of steel of all industries (Bret-Rouzaut and Favennec 2011). It is a great demander of equipment for E&P of hydrocarbons, such as production platforms and drilling rigs. Refined and separated into different products, O&G are used as a source of energy, particularly liquid fuels for transportation and natural gas for heating and generation of electricity. When used by the petrochemical industry, it is a source of raw materials for a range of products, from textiles to plastic bottles.

Such a complex industry has a long value chain that is divided into upstream, midstream, and downstream. The first refers to the activities related to E&P. The midstream encompasses the distribution and transportation of hydrocarbons, such as pipelines and oil tankers. Finally, the downstream involves the transformation of O&G into other products through refining and as a feedstock into petrochemical plants. It also includes retail operations, such as gas stations.

The petroleum value chain starts with the identification of resources where O&G are likely to be found – the first step of the E&P stage. Countries typically have ownership of the subsoil rights and the power to determine the conditions under which companies (or a state monopoly) can locate and exploit natural resources. The total share of revenues kept by the state under a production contract is called government take and it can go as high as 98% in some countries, particularly those with very low cost of production (GAO 2007, Van Meurs 2008). Even at that taxation level, if there is a large difference between cost of production and the international oil price, companies can still make a sizable profit.

After the acquisition of exploratory rights of an acreage from a state, an oil company will gradually invest in activities that reduce the uncertainty about whether a commercial discovery can be made. During the exploration phase, seismic surveys and other indirect analyses are conducted. If results are promising, an oil operator starts a drilling campaign that can comprise several exploration wells. If discoveries are made, new wells are drilled to delineate and characterize the field, which is called the appraisal phase. Finally, after a field is characterized in its extension and production potential, the campaign enters into its development phase where the long-term infrastructure of production is built. Overall, from block acquisition to production, an oil company can take up to a decade and invest hundreds of millions of dollars before starting to receive revenues from the oil production, particularly for deep offshore oil. Even failed campaigns – wells that turned out to be dry or with oil that is not commercially viable to produce – will result in a large number of contracts for oil service companies and manufacturers of capital equipment.

The number of companies in each step of the production chain varies, as well as the associated margins. In the upstream, barriers of entry are high, resulting in relatively few companies being responsible for the majority of production and services. First, countries usually impose restrictions on the activities of E&P, frequently granting privileged access to oil reserves to state companies, which helps them dominate the rankings of oil production (see Table A2.1). Second, projects in the upstream can easily cost billions of dollars, particularly for deep offshore, meaning that few companies can afford the high capital requirements of the sector and the long lead times it takes from initial investment to start of production.

Table A2.1: Top 15 O&G companies by production

Name	Production (in mbpd)	Country of origin
Saudi Aramco	12	Saudi Arabia
Gazprom	8.3	Russia
National Iranian Oil Co.	6	Iran
ExxonMobil	4.7	USA
Rosneft	4.7	Russia
PetroChina	4	China
BP	3.7	UK
Shell	3.7	UK/Netherlands
Pemex	3.6	Mexico
Kuwait Petroleum Corp.	3.4	Kuwait
Chevron	3.3	USA
Abu Dhabi National Oil Co.	3.1	United Arab Emirates
Total	2.5	France
Petrobras	2.4	Brazil
Qatar Petroleum	2.4	Qatar

Source: Forbes (2015)

These market characteristics make the oil industry special in economic terms. Oil companies sometimes can have radically different cost structures, such as 20 times more than a competitor, and still compete in the same market (Pinto Júnior et al. 2007). A NOC such as Saudi Aramco can produce with the lowest costs in the world but still leave space in the market for Petrobras (which produces from the more costly deep offshore reserves) or even Canadian companies that transform oil sands into crude, such as Suncor.

Access to reserves is critical in understanding these particularities of the oil sector. Economic theory expects production to continue until marginal cost equals price. However, in the oil business,

given government ownership of resources, areas with very low cost of production can cut back their output or limit the investment in productive capacity in order to receive more from each unit sold – the monopolist condition of the members of the Organization of the Petroleum Export Countries (OPEC). The consequence is that areas with higher costs in the world are developed before low-cost areas from OPEC countries are depleted.²⁷

Oil was first produced from onshore fields at shallow depth – 69 feet or 21 meters in the case of Drake’s pioneer well in Pennsylvania. With time, advances in drilling techniques allowed tapping deeper reservoirs, although not without a cost, as drilling expenditures rise more than proportionally to the depth: at least fourfold when depth is doubled (IEA 2005, p. 135). Extracting oil from the seabed tends to be much more complex and costly than onshore sites. The drilling of an onshore well costs between \$5 million to \$20 million, while offshore goes from \$20 million to \$100 million (Bret-Rouzaut and Favennec. 2011).

The need to venture into geologically challenging areas and comply with new regulations (such as environmental standards and local content purchase requirements) has led to an increase in the total capital and skill requirements of the industry. Typically, costs of services and equipment in this industry follow closely the price of oil (see Figure A2.2), as higher prices increase the demand for E&P activities in areas that at low prices are not commercially viable (marginal fields or frontier areas).

Significant rents exist in the E&P (Tordo et al. 2011), but as the value chain moves from the discovery and production of oil to transformation (downstream), the market becomes more competitive and the margins tighter. After a barrel of oil is produced, it is sent to a refinery for transformation into products such as gasoline, diesel, and asphalt. Margins in the refinery business are normally thin. A refinery essentially receives a commodity as feedstock (barrels of crude) and produces other commodities. Its market differential is proximity to consuming markets, management, and technical capacity to process a wider range of crudes. Few companies operate refineries independent of other activities in the O&G value chain. Another branch of the downstream segment is petrochemical production, which uses crude oil or natural gas to produce base chemicals that can be chemically transformed to serve as raw materials for plastic and resin production.

²⁷ Although within each country low-cost areas tend to be developed first.

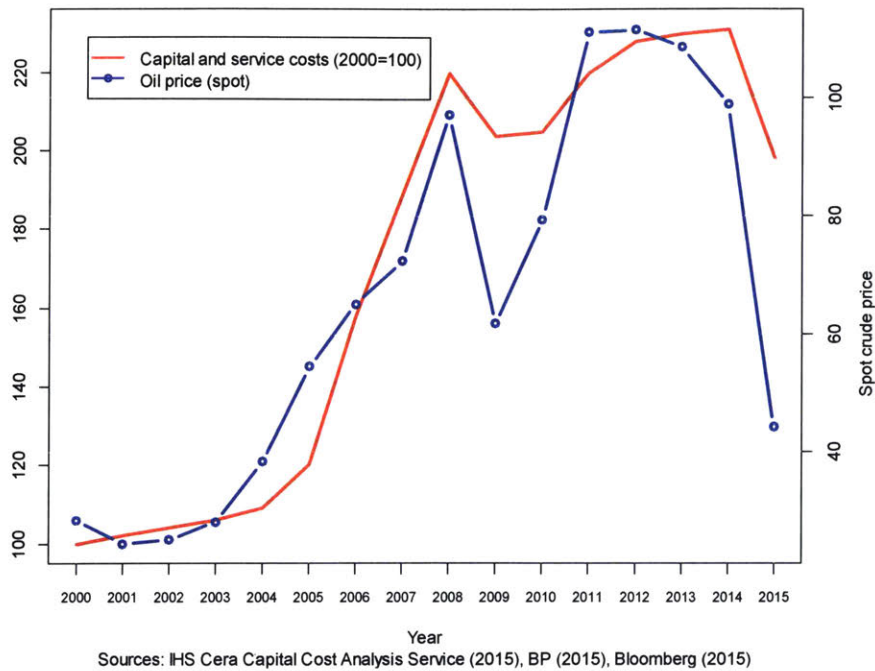


Figure A2.2: Cost of equipment, facilities, materials and personnel in the upstream

In addition to resource-owners (countries) and oil operators (NOCs and IOCs), oilfield service companies are another important player in the industry. Those companies grew by filling niches left by oil operators (outsourcing) and by working in partnership with NOCs that had access to resources but lacked expertise in developing them. The importance of oilfield service companies is evident from the fact that 70% to 95% of all expenditures made by oil companies in the upstream segment are outsourced (Bain & Company and Tozzini Freire 2009, Raymond and Leffler 2006). Within the broad category of services in E&P, it is possible to further open the value chain and divide it in subsegments: reservoir information, drilling, well completion, production, maintenance and logistics, and decommission. Each subsegment varies in terms of its market concentration and opportunities for new entrants and for industrial policies that develop new domestic suppliers. Drilling and well completion are the lion’s share of value, with about two-thirds of the expenditures (Bain & Company and Tozzini Freire 2009). A common characteristic of the main oilfield service companies is the large share of revenues

dedicated to R&D, which can go above US\$1 billion a year (Economist 2012) and reach high percentages as a share of total revenues.²⁸

Summing up, in the O&G value chain rents are high in the upstream and tend to decrease as production approaches final consumer markets. They are particularly high for countries with low-cost resources, like OPEC producers. They get proportionally more revenue per barrel than producers outside of the cartel member countries, but have lower demand for capital investments and technology.

As the most accessible and cheapest sources of oil deplete or are inaccessible, the industry has to venture in harder-to-develop O&G resources, such as deep offshore and unconventional sources. These resources have higher capital and operational expenditures and demand for innovative technological solutions, such as subsea robotics for deep offshore and the combination of horizontal drilling and hydraulic fracturing for shale oil and gas. To meet these challenges, the O&G industry has become more technologically intensive over the years (Perrons 2014, Donnelly 2014). Governments rents are lower, because costs of production and exploratory risks tend to be higher, but there is a greater potential to locally provide part of the goods used in the production, such as drilling ships and platforms, and the associated technological solutions.

²⁸ For example, Schlumberger has consistently invested 2.5% or above per year in research and engineering activities (Schlumberger 2014).

Chapter 3:

From Geology to Public Policies in Mexico: Explaining the Constitutional Reform in the Oil Sector

1. Introduction

Few things were more sacred to Mexicans than the monopoly of oil production by Pemex. The defense of this prerogative of the state oil company was made by members of all parties and faiths, a loyalty that could rival the cult of the Virgin of Guadalupe. Fruit of the expropriation made by Lázaro Cárdenas in 1938, Pemex's privilege as the sole manager of Mexico's oil resources was enshrined in the constitution, celebrated by a civic holiday (March 18), and cited in numerous political speeches as a source of national pride and sovereignty. To suggest constitutional changes in the oil sector has always been Mexico's political third rail, and parties strategically avoided passing comprehensive reforms. Yet, in 2013, after years of a long oil boom in terms of production and prices, what was once considered to be political suicide (Huizar 2015) happened.

Proposed by the administration of Enrique Peña Nieto from the Institutional Revolutionary Party (PRI) and building upon a previous (2008) reform effort made by Felipe Calderón from The National Action Party (PAN), the sweeping reform changed three articles of the Constitution (25, 27, and 28) by the end of 2013. By August of 2014, all secondary legislation had been approved – a total of 9 new laws and amendment of 12 existing laws.²⁹ Despite a strong public media campaign sponsored by the government and the support of the two major parties, it was an unpopular move that was rejected by 57% of Mexicans (Pew Research Center 2014).

In two years virtually every aspect of the petroleum sector changed after being mostly unaltered since the creation of Pemex back in the 1930s. The changes included reducing the government take of oil production, decreasing the state dependence on oil revenues by increasing general taxes, promoting

²⁹ The following laws were enacted: Hydrocarbon Law, Law on Hydrocarbons Revenue, Electric Industry Law, Geothermal Energy Law, National Agency for Industrial Safety and Environmental Protection in the Hydrocarbons Sector Law, Petróleos Mexicanos Law, Federal Electricity Commission Law, Coordinated Regulatory Entities in Energy Matters Law, and the Mexican Petroleum Fund for Stabilization and Development Law. Another 12 laws were amended: Foreign Investment Law, Mining Law, Public Private Association Law, National Water Law, Public Entities Law, Acquisitions, Leases and Services Agreements Law, Public Works and Related Services Law, Organic Law of the Federal Public Administration, Federal Duties Law, Fiscal Coordination Law, Federal Budget and Fiscal Responsibility Law, and the General Law of Public Debt. The reform also comprehended the electrical energy sector and the state company CFE, but electricity is a far less politically divisive issue than the oil industry.

deep modifications in the governance of Pemex and its relations with the workers' union, and, above all, welcoming foreign companies to Mexico to extract oil and gas, sharing the oil wealth with private companies. Furthermore, Pemex and its competitors would now have to maximize local purchases of goods and services through a local content mandate.

The range and timing of a reform that rearranged state functions and the beneficiaries of oil production bring important theoretical puzzles that the current literature fails to explain. First, no exogenous shock played an important role in the policy reform that resulted in distributional changes. The reform was not preceded by regime change, as democratization and the end of the PRI hegemony occurred in Mexico in 2000 with the election of Vicente Fox from PAN. It also was not a by-product of the emergence of a new political force – an outsider or a new political party – that could have brought new ideas and dismantled old political coalitions, given that Mexico's oil has served as a pillar of an unequal social pact of low taxation of the wealthy and redistribution to politically powerful classes (Elizondo 2012, Levy and Walton 2009). Similarly, it was not a result of a short-term, emergency response to the end of the commodities boom and the dramatic fall of oil prices, as spot price decline started during the last quarter of 2014, after the reform had been approved. Resource curse accounts (Karl 1997, Mehlum et al. 2006) would predict the staying power of the then-existing rules of distribution and would, therefore, expect no reform, while a purely technology-based explanation (Nolan and Thurber 2012) would forecast reform to happen much earlier. The current literature provides, at best, conflicting predictions about what motivated such comprehensive reform and the solution of this puzzle calls for a theory that integrates technological needs with politics and the rules of distribution of oil wealth.

This chapter explains the reason behind the reform initiative, its configuration and timing. I argue that a change in the country's resource-base, from low-cost to high-cost resources, altered the incentives of political actors, which in turn decided to promote an energy reform. Mexico's old arrangement for the energy sector, which I characterize as a rent-capture model, became exhausted with the country's conventional oil reserves. The core aspects of this model were the operation by a monopolistic state company, Pemex's heavy tax burden (high government take), the NOC's self-regulation, and its targets being set by political convenience rather than technical feasibility. This model was effective in taxing and distributing rents from low-cost and technically easy-to-produce resources, but it proved to be incompatible with the development of high-cost areas. The old arrangement prevented Pemex from (a) sharing risks with other companies to develop frontier geology, as is usual in

the industry; (b) allocating more resources to invest in exploration and technology, thus securing the replacement of reserves; and (c) facing competitive pressures that could induce better management practices, hence decreasing production costs so it could exploit high-cost areas.

The new geological challenge gave the executive power an incentive to reform since it is both directly responsible for production and the first branch of government to bear the loss and be held accountable for declining oil revenues. However, the constitutional change required the approval by a two-thirds majority in the Congress. While the driver of the reform was geology, the timing and shape of the new rules of the resource sector was not “set in stone”: it was also a direct result of pressure from interest groups, and the distribution of political power and veto points of the lawmaking process (Krehbiel 1998, Tsebelis 1995). The change of who was pivotal in the Congress – from PRI in 2008 to PAN in 2013 – explains why reforms based on essentially the same diagnosis, but five years apart, reached such different outcomes and why PAN was able to exert a large influence in the latest reform, including reducing the privileges of the workers’ union of Pemex, which has been a longtime PRI supporter and funder.

While the reform went against the interest of the workers’ union, the government sought a support base in the business sector and accepted a compromise that benefited suppliers: the adoption of a local content mandate, which has the aim of forcing oil companies to increase procurement of goods and services from Mexican firms. The mandate was initially opposed by the draftees of the reform and by the management of Pemex, and is detrimental to a policy of maximizing oil rents and speeding up production. However, it was ultimately cast in law because business associations and their political representatives (in both parties) saw in it an opportunity to guarantee a share of the future oil industry contracts. To achieve the local content targets with minimum inefficiency costs, the Mexican state reengaged in industrial policy – a major departure from the country’s mostly free trade approach to economic policy.

This chapter is organized as follows. Following this introduction, Section 2 presents the theoretical framework that explains how a country’s geological endowments can influence the rules of distribution of the resource sector by providing a different set of incentives to policymakers and interest groups. Sections 3 and 4 analyze different historical periods of the Mexican oil industry against the proposed theoretical expectations, drawing from fieldwork that included participant observation at the Mexican Ministry of Energy during the summer of 2015, oil field data analysis, interviews with stakeholders and archival research. Section 3 starts with the energy crisis of the early 1970s – a period

of low rents – and continues to the oil abundance era that started with discoveries in Chiapas, Tabasco, and the Campeche Bay and lasted until the peak of production in 2004. Section 4 discusses the reformist push after Mexico’s peak oil and the 2008 and 2013 energy reforms, its geological drivers, the role of political institutions and veto points. It then examines how the need to support the development of high-cost oil fields and new distributive pressures in the form of local content influenced the new configuration of the sector. Finally, Section 5 concludes.

2. The state, resource endowments and the rules of the natural resource sector

Sovereign states own subsoil rights – with the exception of the United States – and governments play a fundamental role in all aspects related to petroleum resources. The first set of decisions governments face regarding the oil industry is whether or not to explore for petroleum, at what pace to do so, and who should undertake such exploration (Tordo et al. 2009). Tied to these choices is how much of the rents should be captured by the state and how they should be split within the many sectors of society, assuming resources are commercially exploitable. These policy decisions are formalized as legal regimes and state bodies, such as ministries of oil, regulatory agencies, and national oil companies and their prerogatives. This allocation of rules defines the main stakeholders and their relative power and may represent an equilibrium arrangement where groups who benefit from it will have a strong interest in preserving the *status quo* and will militate against reforms that change the distribution of wealth from oil production.

In Mexico, oil wealth has been a pillar of an arrangement that benefited entrenched insiders and has maintained a ruling coalition insulated from societal pressures (Díaz-Cayeros 2013, Levy and Walton 2009). Oil revenues allowed the political class to dispense public favors, including contracts and jobs, without having to resort to taxation, softening their budget constraint (Robinson and Torvik 2006, Kolstad and Wiig 2009). The PRI, due to its long dominance of Mexico’s political system, has particularly used the oil sector to deliver goods to its large patronage network through Pemex and its oil workers’ union, whose leaders have been members of the party (and elected officials) and have influenced policy initiatives that affect the sector.

These factors make the reformist episode in Mexico all the more puzzling. Existing arguments provide two opposing expectations about the Mexican state and its oil sector. One set of explanations, identified with work in the resource-curse studies, highlights the captured nature of oil-rich states and

the inability to reform against the interest of an existing rent-seeking coalition. Another, based on a rational expectation of state behavior and technological imperatives, would expect reform to happen much earlier in order to maximize oil extraction. Unfortunately, neither of them can fully account for the Mexican case.

The strong connection between the ruling coalition and the existing stakeholders of the resource sector would lead to a prediction of continuity in the Mexican case. This expectation would be in line with a strand of the resource-curse literature that emphasizes that pre-existing institutions affect how resource wealth subsequently will be managed (Karl 1997, 2007, Mehlum et al. 2006, Robinson et al. 2006). The same prediction holds when applying the framework provided by Luong and Weinthal (2010), who mostly side with an emerging literature that positively evaluates the role of oil on political and economic outcomes. In their account, ownership regime matters because it defines societal expectations and the direct claimants from the exploitation of natural resources. Mexico's state ownership with direct control of production is precisely the one most associated with a curse as it empowers the governing elites and the enterprise bureaucrats. In these accounts, the reform is unexpected, because of the power of entrenched insiders and the political costs of a constitutional rearrangement.

An alternative explanation can be drawn from Nolan and Thurber's (2012) analysis of the state choice of oil company. A rational decision-maker would select an international oil company when it wants to develop frontier areas, where risks are high and domestic expertise may be lacking. States are theoretically and empirically likely to choose private operators to develop frontier resources, which they measure by the depth of offshore resources.³⁰ The exceptions—the Norwegian Statoil and the Brazilian Petrobras—are national oil companies that developed their own technical and managerial capabilities for deep waters. From this perspective, the puzzle is why Mexico took so long to reform its energy sector given that it failed to develop deep offshore resources for so many years. What is missing from the perspective offered by Nolan and Thurber (2012) are explanations of the timing of reforms in Mexico after years of inaction and why, compared to Brazil, Pemex failed to develop capabilities, despite similar country-level characteristics and Mexico's greater oil production experience.³¹

³⁰ The literature includes many studies on why states expropriate oil companies (see, for instance, Mahdavi 2014, Vernon 1971, Warsaw 2012) but it lacks analyses of why states decide to open their sector, limit rent-taking and adopt local content regulations, such as in the Mexican case.

³¹ It is worth noting that within Mexico opponents of the initiative have used geopolitical explanations to account for the reform, particularly that it was driven by pressure from the US to secure a long-term supply of oil and

The perspectives reviewed above generate contradictory expectations about Mexico. In order to integrate them, it is necessary to reconcile both the technical challenges of oil production, as highlighted by Nolan and Thurber (2012), and the political constraints and incentives involved in legislative changes. To this end, this section takes up the core of the theory elaborated in Chapter 2 and applies it to the Mexican case. It connects geological endowments, and their potential for rent capture or creation, to the incentives for policymakers and interest groups to bargain over the rules of the natural resource sector. I claim that the extraction of resources from different geological endowments will be most compatible with specific configuration of rules. Changes in the resource base will thus pressure the equilibrium that sustains a given arrangement of the extractive sector. This is so because oil production is influenced by below- and above-ground factors. Below-ground challenges will be more demanding of above-ground solutions to facilitate extraction. As a result, a challenging resource base will increase the returns for political actors to invest in rules and practices that can support the development of the available resource base. However, incentives to the executive alone do not change laws: reforms are a result of the bargaining process between the executive, lawmakers and society's interest groups and may require a shift in supporting coalitions.

In the Mexican case, the old equilibrium was based on the easy availability of oil rents, which had been shared mainly by the executive and the Pemex workers' union. As long as the executive was comfortable with its share, it had little incentive to change the foundations of the sector and to challenge the interests of the workers' union. With production decline and cost per barrel rising, rents from oil dwindled and the executive was bearing the losses, since the union continued with above market wages, overemployment, and a generous pension regime. A new legal framework that altered the rules of distribution became politically possible when the PRI sought the collaboration of the PAN, sidelined the workers' union, and attracted the support of the business sector, the latter interested in local content provisions. In order to facilitate the development of high-cost oil, the executive also restrained its own rent-taking and invested in strengthening its regulatory and policymaking functions, to support the creation of reserves and attraction of investors.

markets for its oil companies (Domínguez Vergara and Vela Coreño 2015, Martín del Campo et al. 2015). For many reasons, this seems unlikely to have been a driver of the initiative. American crude production was surging thanks to the shale boom, and Mexico was not negotiating a rescue package or a trade deal with the US. In other words, there is little evidence that the US had leverage towards Mexican politicians, and it is not clear why the latter would accept changes imposed by their neighbor. Likewise, the more extremist view of the reform as a coup by the elites to loot the nation (Morales and Dávalos 2015) does not reconcile with the fact that Mexico's oil model has served its elite well.

From resource endowment to rules of distribution of oil wealth

From the point of view of the firm, investment decisions made by oil companies to engage in exploration follow an equation of cost-benefit analysis that takes the following probabilistic approach (Bhattacharyya 2011):

$$EMV = P \times NPV - E,$$

where *EMV* is the expected monetary value, *P* is the probability of a successful discovery or the expected ratio of non-dry wells to the total number of wells drilled, *NPV* is the net present value of developing the field, and *E* is the exploration costs. Consequently, high geological risk and the costs of the exploratory activity itself will decrease investments in exploration, while the size of a hypothetical discovery, the expected oil price, and the tax regime will affect the *NPV*.³²

To pump oil out of the ground, it is first necessary to find it. Geological risk varies and is a major variable in the investment decision of oil companies. Risk is higher in frontier areas where exploration is still in its early phases, making it more likely that large sums of capital may be spent without resulting in a discovery. Surpassing this challenge imposed by nature in detecting a hydrocarbon formation is only the first step for the commercial extraction of oil. Operational success will depend on the capacity to produce the resource at a cost below its selling price. Oil can be produced from a variety of sources, from the very low-cost giant fields in the Middle East and North Africa (MENA) region to the costly deep offshore, shale or oil sands, which are unconventional resources. Not only is it easier to find oil in the Middle East (lower geological risk) but it is also much cheaper to extract it. For instance, according to data from the International Energy Agency (IEA 2015), new projects in Iran, Iraq and Saudi Arabia are estimated to be as low as \$11 per barrel. In contrast, deep offshore projects in West Africa or in Brazil's pre-salt layer are estimated to cost at least \$50.

Another crucial variable for the industry is the time it takes from discovery to the start of production, or first oil (Jan et al. 2008). Complex deep offshore projects have a long lead time – contracts provide for up to ten years just for the exploration phase (Johnston 2003). Cost overruns and delays during the development phase are common, in part due to shortages of specialized services, materials, and technology (Inkpen and Moffett 2011). While conventional oil is produced using standard,

³² This section briefly summarizes the theory elaborated in chapter 2.

off-the-shelf technologies, deep offshore oil extraction tends to follow customized designs and is a fast evolving area for the development of new technological solutions, such as subsea robotics (Leffler et al. 2011, Lloyd’s 2014). Its operational risks are high, as shown by the Deepwater Horizon oil spill that led BP to the brink of bankruptcy (National Commission... 2011, Robinson 2014). Given the high-capital requirement and market and geological uncertainties, companies tend to pool resources and develop deep offshore areas in consortiums (Raymond and Leffler 2006), including Brazil’s Petrobras, which is a leader in the sector. Long lead times and the need to use novel technology introduce a number of operational, market, and political risks. Production of oil and gas from shale has the advantage of having a shorter lead time, but operational costs and depletion rates are unusually high: total recoverable oil is extracted in the first three years (IEA 2015), and so production requires continuous investments. This is also an area of very active R&D for cost reduction and increase of oilfields recovery rates. Table 3.1 summarizes different industry characteristics of exploiting conventional and unconventional resources:

Table 3.1: Stylized differences from conventional and unconventional oil

Type of resource	Geological and market risks	Technology required	Capital and operational investments	Rents per barrel
Conventional / low cost	Low	Standard	Low	High
Unconventional / high-cost	High	Novel / Customized	High	Low

Source: Author's elaboration

Given the above considerations, we can derive the political consequences of developing different geological endowments. Abundance of conventional oil deposits generates high rents and demands very little in terms of capabilities of oil companies and institutional complementarities, freeing governments to focus on strategies of rent-capture. Government can prioritize the fiscal returns from the oil sector and production can be sustained at high levels, even when companies are inefficient and the government take is high. Demand for capital goods and skilled personnel will be low, per unit of output, thus reinforcing the fiscal component of the natural resource sector over other potential impacts. This pattern conforms to the image of the oil industry as an enclave that has few linkages to the rest of the economy other than fiscal revenues. According to this view, “Oil and gas extraction can occur independently of the political processes of a country” (Inkpen and Moffett 2011, p. 43), and it does not require the cooperation of the citizenry or much support from state organizations. Likewise, another

common claim is that oil companies “buy relatively few inputs from local firms and thus generate few backward linkages to the local economy” (Ross 2012, p.45).

Conversely, where a resource base exists but is technically challenging and has a high-cost of production a government will be more constrained in its ability to tax the sector highly. Instead, the development of the nation’s resource base will benefit from the existence of institutional complementarities that support the sector. This type of resource base can induce strategies of rent-creation through innovation rents.³³ Furthermore, when companies engage in high-cost oil production, there is a higher demand for capital goods, specialized services, and skilled personnel. The importance of industrial demand for developing these resources can be highlighted by the fact that more money can be exchanged in the form of industrial and service contracts than in rents distributed by governments, particularly when selling prices become closer to break-even levels. This demand will be politically important as local supplier firms will have an incentive to lobby for rules that mandate that oil companies prioritize them in their procurement.

Those distinct geological endowments and associated industry characteristics create incentives for political actors who are involved in setting the rules of the natural resource sector. The executive power, as manager of national resources, is the first affected by these incentives, and I expect that reforms will be initiated by the executive. However, the executive faces political constraints that can be either distributive pressures, or veto points from the legislative action (Krehbiel 1998, Tsebelis 1995), or both.³⁴

Figure 3.1 conceptualizes how a key component of a country’s geological endowments, extraction costs, can influence the rules of distribution of oil wealth – the definition of who can extract, under what tax level, and who benefits, in the supply chain, from the activity. Extraction costs provide direct incentives for the executive, which is interested in the revenues from oil production. However, for such production to be started and sustained, extraction costs have to be below the market price for oil. Extraction costs also affect interest groups (such as industry associations and workers’ union) by shaping their distributive demands and expectations about future costs from the extractive activity and potential

³³ As explored in chapter 2, to Schumpeter (1942), one of the functions of the entrepreneur is to rearrange patterns of production to produce an old commodity in a new way. Schumpeter’s definition characterizes well the contemporary oil industry insofar as the extraction of a barrel from an unconventional resource requires more technology to compete in the same market as conventional oil producers, which are naturally competitive because of a favorable geology.

³⁴ For instance, a coalition that is concerned about environmental impacts from unconventional oil production and is powerful enough to serve as a veto point can block production from this source of oil.

benefits. The rules of distribution will be the result of a winning coalition that arises from the bargaining between the interest of the executive, parties and pressures from interest groups. Low-cost oil will demand very little in term of institutional complementarities because it can be produced with short lead times, has low exploratory and operational costs (and thus can support higher levels of government take), and requires only standard technology that can be acquired in the market. On the other hand, the production of high-cost oil will be facilitated by rules that secure the stability of investments against expropriations, including the public perception of fair contracting between oil companies and the state (Stiglitz 2007); adjust the government take to the business risks and allow for risk-sharing of projects between different companies (Inkpen and Moffett 2011, Jahn et al. 2008); provide a stable business environment and well-staffed regulatory apparatus (Johnston 2003); and support an innovation ecosystem that facilitates investment in public goods such as human capital and R&D (Morais 2013).

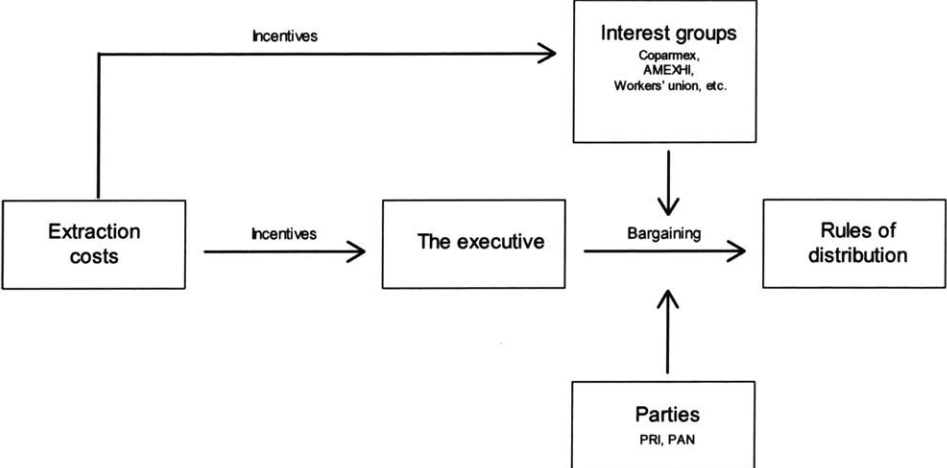


Figure 3.1: Pathways from extraction costs to rules of distribution in Mexico

I also predict that under high-cost oil, where the demand for capital goods and services is higher, it is likely that pressures to include local suppliers in the production chain in the form of local content mandates will increase. Those mandates are not, in any way, necessary for the development of high-cost oil, and they may even be detrimental to it in terms of time and cost overrun. However, I expect it to arise due to the political benefits that such policy can confer to firms and lawmakers. Given the need to minimize inefficiency costs from the enactment of local content, and the fact that the executive wants to maximize oil rents, I expect the adoption of such mandates to be followed by industrial policies that aim to coordinate investment and build capabilities.

To sum up, resource endowments vary in their characteristics, rents per unit of output, and what it takes to extract them. All these generate political incentives on how to structure the rules that structure the creation and distribution of wealth from the resource sector. Where natural resources are abundant and easy to extract, there will be little incentive to improve the efficiency of production or invest in technology or the supply chain. On the other hand, where resources exist but rents are few, an arrangement to support rent-creation will facilitate the development of the natural resource sector. However, such arrangement requires an alignment of political incentives to be enacted, and local content may serve as an inducement for policymakers.

To test the predictions generated by the theory, I examine the Mexican oil experience in three moments: (a) the period immediately before the oil boom, when reserves and rents were few and the country became a crude oil importer; (b) during the oil boom, when reserves and rents were abundant; and (c) after oil production peaked, when Mexico's low cost oil reserves started to deplete.

I document steps towards rent-creation and technology investments in the period before the oil boom but not during the years of production abundance. As the evidence shows, when oil production was at its highest levels, Pemex became a major source of fiscal revenues for the treasury and benefits for its own workers, but not of technology development or of local industrial demand. As the low-cost and technically easy to exploit sources of oil depleted, the executive pushed for changes in the rules of the oil sector, as predicted by the theory. A comprehensive energy reform was only passed after the PRI, which was a veto point in the 2008 energy reform, returned to the executive and became directly interested in changes that could boost production. With the role reversal, the PAN became pivotal and was able to extract concessions from the executive, including fracturing the alliance between the Pemex workers' union and the PRI, at the same time that a new alliance was forged with the business sector, lawmakers and the government over local content requirements.

3. Mexico's oil sector over time

3.1. The 1960s and 1970s: From relative scarcity to abundance

Although Mexico had a long history of oil production, by the late 1960s and 1970s output levels were remarkably low considering the size of the Mexican economy. Proved reserves decreased from 28 years of consumption at the time of expropriation in 1938 to only 18 in 1970 (Sanchez 1983). In fact, by 1971 the country was relying on crude oil imports to supply its energy needs, starting a self-sufficiency

crisis (Morales 1992). As shown in Figure 3.2, net crude and natural gas production were minimal during the early 1970s, thus affecting Mexico’s balance of payment and the future of its most important state company, Pemex.

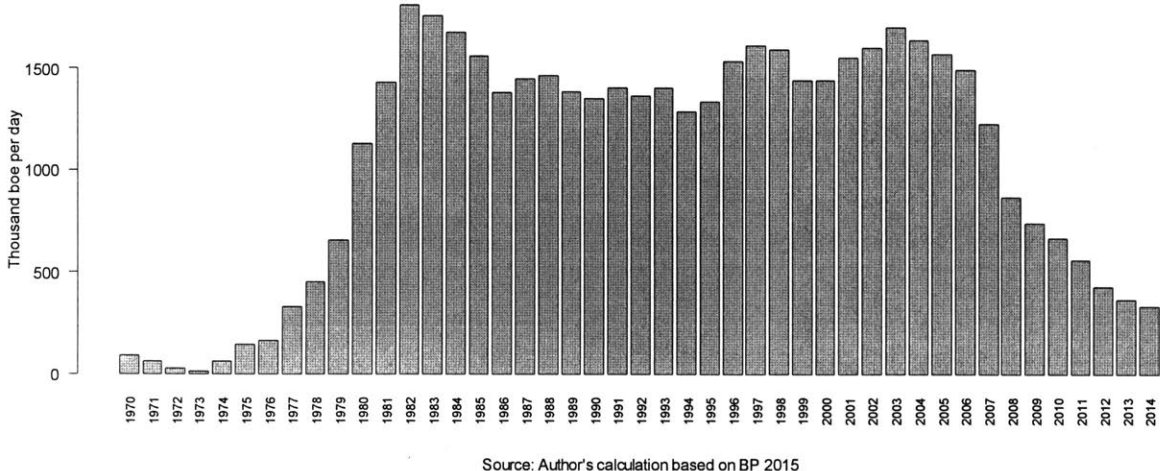


Figure 3.2: Mexico’s net production of crude and natural gas (in boe)

The deficiencies of Pemex in management and technology – with a resulting decline of net production – led the Mexican government to put in place a strategy to revitalize and support the growth of the petroleum industry. Because of the confrontational nature of the oil expropriation in Mexico, particularly during the early days, Pemex suffered from limited access to frontier oil technology, repair parts, drilling rigs, additives and foreign technicians as it broke ties with the international oil industry (Barbosa Cano 1992). In 1965, under the administration of Jesus Reyes Heróles, Pemex sponsored the creation of the Mexican Institute of Petroleum (IMP) with the intention of developing indigenous technology and providing technological services to Pemex. This included the geological study of prospective areas, application of techniques to increase recovery factors from producing wells and developing materials used in oil refining and petrochemical manufacturing (IMP 2008).

On another front, Pemex was given more resources to invest by a combination of tax reduction, direct government compensation for subsidies, and (at last) price increases. By the 1960s, the government taxation of Pemex was reduced from about 21% in the late 1950s to 12% (Meyer and Morales 1990). This helped the finances of the company but Pemex still had to sell gasoline at subsidized prices, which limited investments from retained earnings. From 1971 to 1973 the Mexican government

compensated Pemex for gasoline subsidies by directly injecting into the company money that in 1972 was equivalent to 6% of the firm's total revenues. In 1973, the politically more costly move of raising domestic prices of gasoline and diesel was adopted, ending a long price freeze that had been in place since 1959 (Meyer and Morales 1990). The move was in line with Pemex's business plan for 1971-1976, which focused on raising domestic prices to support investment needs, increasing efficiency, reducing production costs, and intensifying the investments in human capital and science (García Páez 1989).

The pre-boom period shows a Pemex that, for the first time, invested in technological development and support, paid less taxes to the government and finally charged realistic prices for its products. This would be expected – according to the theory presented in this chapter – when rents are not abundant and the firm needs to invest to find and develop new reserves. This reality of relative scarcity that required more realistic prices, technological mastery over resources and optimization of current producing fields started to change with discoveries in the states of Chiapas and Tabasco (Reforma and Samaria fields) in 1973. A few years later, the discovery and development of the Cantarell field in the Campeche Bay area allowed Mexico to become an important oil exporter again. As the story goes, the field was “discovered” by a fisherman called Rudesindo Cantarell Jimenez who complained to Pemex of oil stains in his fishing nets. As happens in some oil areas, petroleum can seep to the surface and provide an important hint to the location of a reservoir.³⁵

Cantarell had many characteristics of a low cost oil reservoir. It is a complex of fields located in shallow waters, from 35 to no more than 100 meters, which makes it easy to install the infrastructure. It also did not require extensive drilling, as the reservoir is accessed beginning at 1500 meters. In addition to hosting one of the largest reserves in the world as a super-giant field, Cantarell is a naturally fractured carbonate reservoir with high porosity and permeability, geological features common in Middle Eastern fields. This means that oil can easily flow, further reducing production costs.

The discovery of Cantarell in 1977 radically changed Mexico's oil industry. Suddenly, a super-giant field, relatively easy to develop and operate, was available to the nation. The jackpot became even more valuable as pressures from the Organization of the Petroleum Exporting Countries (OPEC) signaled the continuation of a high oil price scenario and an era when access to oil reserves was of substantial importance to a country's economy and geopolitics. Until this point, Pemex's role in Mexico's industrial policy was to provide cheap energy to the domestic market, thus supporting local industrial growth, and,

³⁵ The story of the fisherman is disputed as a myth by Lajous (interview 2015). Myth or not, the story is based on the fact that Cantarell, as a shallow-water super-giant field, was easy to find.

to a lesser extent, directly investing in the emerging field of petrochemicals. The abundance of Cantarell broadened the menu of possibilities available to policymakers on how to use Pemex. These could be summarized in three broad distinct choices for the country (García Páez 1989): 1) use the new discovery to foster domestic industrialization through cheap domestic energy prices but only export a marginal part of the production; 2) pace the development of the field to domestic absorptive capacities, limiting exports to avoid currency overvaluation and inflation; and 3) develop it as quickly as possible so as to take advantage of the high oil prices and accelerate income flow from the field.

Each possible choice was attached to different political incentives. In Mexico, presidents have a six-year term (*sexenio*), without reelection, and they tend to drastically lose their political power after they leave *Los Pinos* (Castañeda 1999). The president José López Portillo (1976-1982) was at the beginning of his term when Cantarell was discovered and he opted to develop it as fast as possible, without waiting for the national capacity to absorb the influx of foreign reserves or developing local suppliers so they could build capabilities and benefit from the investments being made (García Páez 1989). The geological characteristics of the Cantarell field made it possible to take the short-term rent-maximization strategy: its technically simple characteristics and high volumes could be developed in record time (Pratt et al. 1997). López Portillo's vision was to leverage investments using external credit (and technology and capital goods) in order to develop new oil fields as fast as possible. Growth was financed by loans and the debt of Pemex increased from \$925 million in 1974 to \$20 billion in 1981, or from 9% of the share of the public foreign debt to 38% (Meyer and Morales 1990). The benefits were expected to come from exporting the oil at record price levels that prevailed after the second OPEC oil shock. As López Portillo famously declared in 1976, it was time for Mexico to manage abundance.

The industrial policy of the oil boom resembled an enclave development: financed with foreign capital, using foreign capital goods, and producing for foreign markets. The engineering of the Bay of Campeche was developed by Brown & Root, a subsidiary of Halliburton, with little to no inputs from local companies (Pratt et al. 1997, Sanchez 1983, and interview Lajous 2015). The fast track development resulted in a disregard of safety standards³⁶ and higher capital costs than would be the case of a similar offshore projects.

Ultimately, the plans of Brown & Root and Pemex to rapidly boost Mexico's oil production were successful and Cantarell started production in just three years after discovery, with a fast growth curve,

³⁶ For example, a major blowout during the drilling of the Ixtoc-1 well resulted in a loss of around 30,000 barrels of oil per day during June 1979 to March 1980, with severe environmental and financial costs (Pratt et al. 1997).

as seen in Figure 3.3. The production from the traditional onshore oil region areas (North and South) was quickly outpaced by developments in shallow waters, particularly from the Cantarell field. In contrast, a typical deep offshore field is much more complex to develop and can take more than ten years from initial exploration to the first oil (Inkpen and Moffett 2011, Leffler et al. 2011) – a period that would far exceed the six-year mandate of the Mexican presidency.

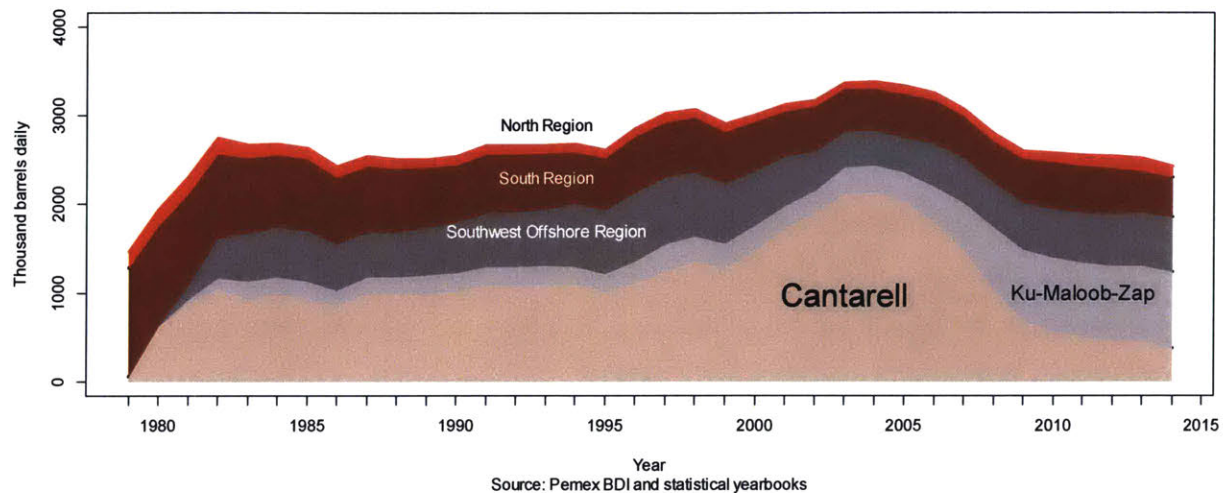


Figure 3.3: Mexico's oil production by main assets and regions

However, as Mexico's production started to boom, the world oil market was beginning to reverse its trend: from an era of scarcity and high intra-cartel coordination of production and prices to one of commodity abundance and disagreements among OPEC members (Adelman 1995). If in the years of 1979 and 1980 the oil price was between \$31 and \$36 (BP 2015b), by 1986 it was being sold at \$14 a barrel. If from the income side price reduction led to lower than expected revenues, the service of the debt was increased by the US decision in 1981, during Paul Volcker's tenure in the Federal Reserve, to almost double interest rates.

While policymakers may have lacked the capacity to forecast the drastic reversal of the oil prices – the prevailing expectation of the time was that a bullish market would continue – the decision to develop oil fields at full speed was not technically grounded and it resulted in substantive long-term costs in terms of debt and dependency on the oil sector to public finances. Additionally, it maximized oil rents over other activities that could have generated spillovers along the oil production chain, as the domestic industry and local technological development were purposefully neglected.

Mexico was the first Latin American country to default in the 1980s, initiating the “lost decade” period of the region. The same president who expected to receive all the credit for developing Mexico’s oil industry had to deal with a severe economic crisis, even opting to nationalize the bank system before leaving office. Despite all the evidence, López Portillo defended his decision to develop in record time the oil industry with foreign loans.³⁷

3.2. Living off rents: From the 1980s to the mid-2000s

Miguel de la Madrid (1982-1988) took office after López Portillo and presided over a dire economic situation characterized by a shortage of foreign reserves. Oil production stabilized at little less than 3 million barrels per day, more than the three times the recorded number of 1976, which was 894 thousand barrels per day (kbpd). Consolidating a trajectory that started in the previous administration, the oil sector became critical to the Mexican treasury (see Figure 3.4). If in 1977 the oil sector was responsible for 20% of all public revenues, in 1983 it reached a peak of 49.8%. From then on, Mexico’s public finances had been *petrolized* and oil rents continued to be the most important contribution of the oil industry to the Mexican economy.

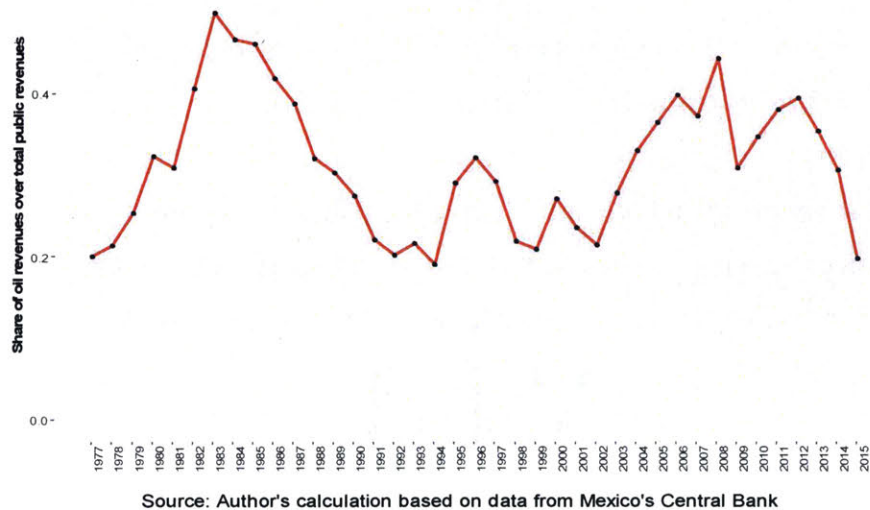


Figure 3.4: Mexico's fiscal dependency on oil revenues

³⁷ In his words, in a free translation from the original: “To not take the opportunity offered to us by the circumstances to get credit to build our oil and industrial installations at a rate that no country has ever achieved and, moreover, to export oil in exceptional and short conditions presented to us, would have been short-sighted and stupid” (López Portillo 1982).

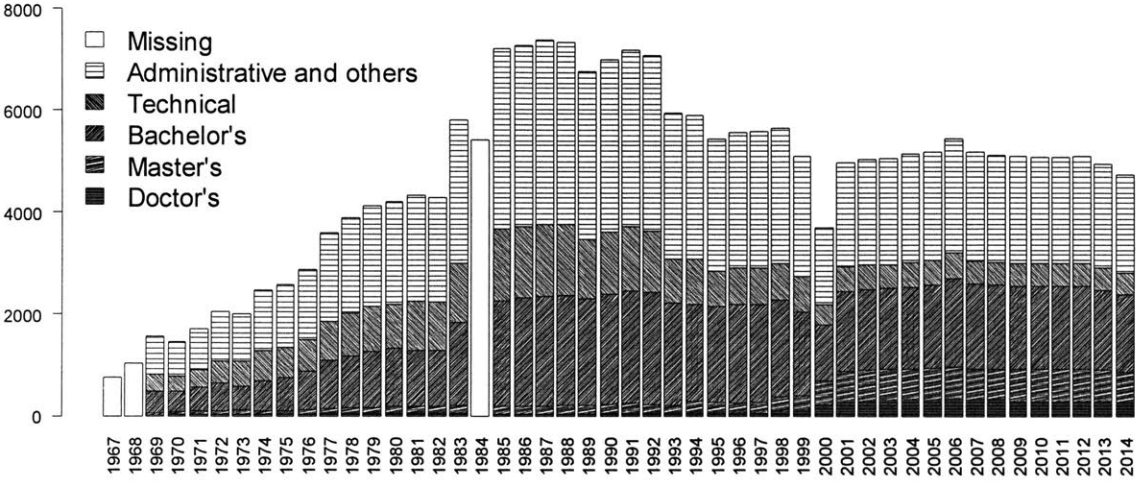
An attempt to make Pemex develop local suppliers was made during the mid-1980s but was short-lived, as the theory presented here predicts. During the debt crisis of the 1980s, it became strategic to develop national suppliers in order to save foreign reserves. Pemex conducted a program to increase domestic purchases of capital goods along with certifications of suppliers done by the IMP. At the time, only a third of Pemex's purchases of capital goods were supplied by Mexican manufacturers (Randall 1989).

Such industrial policy failed and was discontinued. The Mexican state tightened its belt during the crisis and the easiest budget line to cut was capital investments. Public gross fixed capital formation decreased from an average of 10.45% of the GDP in 1980 and 1981 to 6.72% between 1982 and 1986. The most drastic reduction was observed in public investment in machines and equipment, which for the same period went down from 3.35% of the GDP to 1.48%. Investments made by Pemex decreased even further. Compared to all sources of public investments, Pemex's share decreased from a peak of 40% in 1981 to a low of 27% in 1985 (Casar and Ros 1989).

Furthermore, Pemex privileged its relations with foreign suppliers vis-à-vis domestic ones. For instance, following the price fall of 1986, Pemex delayed payments to domestic suppliers while promptly paying foreign contractors, which raised the uncertainty of being a supplier for Pemex (Randall 1989). It also did not help that domestic suppliers lagged behind in terms of technology, and no wide effort to reduce the technological gap was adopted. This led to the purchase of important equipment with technological content, such as offshore systems, from foreign suppliers (Meyer and Morales 1990). Finally, after the large investments made in the short time span of 1976 to 1982, Pemex invested modestly in activities such as drilling (see Figure 3.6 later). Therefore, the opportunity to use the government purchasing power to stimulate local suppliers had mostly been lost and would only return by the end of the 2000s.

Likewise, the period of oil abundance did not lead to more investments in local oil technologies and in the IMP. This was in contrast to the importance of the IMP before the oil boom. To Morales (1992), the work of the IMP in seismology, gravimetry, and magnetometry had played an extremely important role in the Campeche Bay discoveries. Dominguez Vergara and Zavala Osorio (2008) go so far as to say that IMP had its golden age during its first 10 years, before the oil abundance. A significant problem for the IMP started in 1986 when it stopped receiving from Pemex an exclusive budget for R&D activities. Instead, IMP had to rely on contracts sold to clients and fund research with the profits from these contracts (Interviews Porres 2015, Ríos Patrón 2015). This led the institute to gradually move away

from R&D activities and become a service provider for the industry. An analysis of various annual reports of the institute available in its Mexico City headquarters reveals that many projects were unrelated to research activities and instead focused on technical assistance and training. Using the same source, I compiled the breakdown of IMP employees by educational levels over time (Figure 3.5).



Source: IMP annual reports

Figure 3.5: Breakdown of IMP employees by educational level

Historically, in the IMP the number of employees with graduate education has been a small fraction of the total workforce. In fact, by the 1990s the payroll of the institute had more drivers than PhDs.³⁸ The situation started to change in the 2000s. First, the IMP was recognized as a national center of research, bringing new public sources of funding to the institution (outside service contracts) and more administrative autonomy. In 2001, its founding decree was altered to add graduate educational training as one of its missions and started to offer courses up to the doctorate level. Only in 2008 did it receive a strong source of funding from a new duty of 0.65% on oil sales that is dedicated to R&D.

This weakening of IMP precisely during the oil boom, and a growing distance from Pemex, was consistent with the technology strategy of Mexico’s oil company. Rather than being a developer, Pemex focused on buying technology (García-Colin Scherer 2011) – or worse, just services with technological content. This led to what some call “a culture of subcontracting” (Playfoot et al. 2015, p. 14), or

³⁸ For instance, in 1990, IMP’s annual report (*Informe de Actividades 1990*) registers 57 employees with doctorate degrees in various areas but 116 drivers, 32 gardeners and many more support staff (1200 administrative staff workers plus 418 in support services).

contratismo, as Mexicans call it. Based on interviews with former IMP workers and Pemex executives, I summarize the three main issues that help to explain why Pemex did not develop capabilities like Petrobras or Petronas: 1) neglect of internal development of technology; 2) an inability to evaluate and sanction purchases of technological services; and 3) the lack of a strategy to transfer, absorb and independently apply services of high technological content acquired by the company.

Throughout most of its history, R&D has not been a priority to Pemex. Founded in 1938, Pemex took almost 30 years to set up a research institution to support its activities. IMP was created as a decentralized agency, funded by Pemex but not an integral part of the company (including a different salary and benefit structure, less attractive than those at Pemex). A rift has grown over time between the two, with Pemex executives seeing little value in the activities of the IMP and the institute becoming a service provider to Pemex like many others (Domínguez Vergara y Zavala Osorio 2008). Pemex, for example, would deny access to its facilities and fields to IMP researchers. Alma América Porres, an IMP employee and, at the time of writing, a commissioner at CNH, tried in 2010 to negotiate access to fields in the Chicontepec area where Pemex has been struggling to increase production and has a clear technology challenge. Pemex gave access to international oil service companies to experiment with different production alternatives but not to IMP, a signal that the organizations lacked cooperation (Interview Porres 2015). Former Pemex managers recognize the company's historical neglect of a R&D strategy and blame it on the short-term pressures faced by the company, leading to a risk-averse corporate culture, and lack of competition. "Pemex has never been really eager to innovate. Because the *status quo* was good enough. No competition, no complaints. We could do better, yes, maybe, but that would require us to work more. Why bother?" Jesús Reyes-Heroles González-Garza, former CEO (2006-2009) and Minister of Energy (1995-1997), himself the son of a Pemex CEO and founder of IMP (Interview Reyes-Heroles 2015), thus summarized the corporate culture with an ironic tone.³⁹

The account is confirmed by multiple sources and is part of a broader issue at Pemex, which preferred to acquire services rather than become a developer of them. In fact, Pemex made a conscious decision to be a follower of technology, partnering with companies like Schlumberger, Bechtel, and Halliburton in their more demanding services, like enhanced oil recovery (EOR), rather than trying to

³⁹ Carlos Murieta Cummings, former Corporate Director of Operations at Pemex, adds that the company repeatedly failed to see value in R&D investment: "We don't understand the value of research. We don't understand, we don't support and sometimes we don't want even facilitate access to our facilities" (Interview Murieta 2015).

develop their own solutions. This lack of a developer technology strategy prevented Pemex from capturing Schumpeterian rents from innovation and tapping Mexico's unconventional resources.

The second issue was an inability to choose technology projects – Pemex did not have the expertise to choose which solutions to invest in. Hence, even to determine which technology to buy it is necessary to have a qualified internal team capable of matching needs to the right technological partner, and Pemex fell behind in terms of investments in human skills in comparison with other oil companies, including state-run (Coronado 2014, Playfoot et al. 2015).

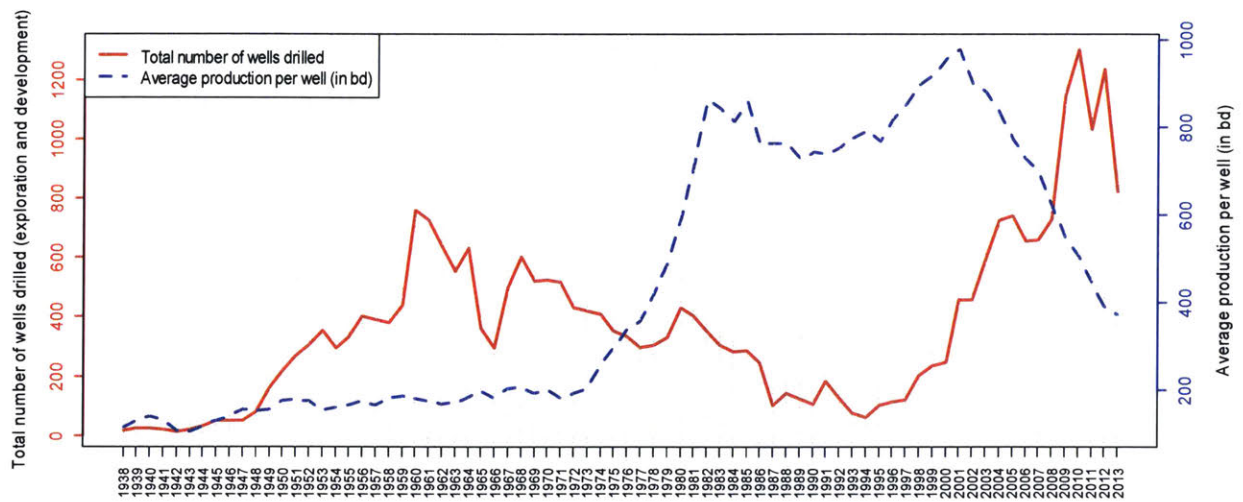
Third, when Pemex contracted projects with high-technological content it did not incorporate this knowledge into the company. In other words, the knowledge did not become an asset that Pemex could apply elsewhere or sell it. A major example was the use of nitrogen injection to boost production from Cantarell in the early 2000s – it was the biggest such project at that time but Pemex commissioned the American company Bechtel as project manager. It contracted the technological service but did not learn how to do the process and autonomously replicate it in other fields (interview Lajous 2015). Pemex, thus, failed to use the opportunity to develop operational capabilities, while advanced oil firms are investing in higher-order capabilities (dynamic) so they can face the growing production and institutional challenges of the industry (Garcia et al. 2014, Shuen et al. 2014).

The boost of production in Cantarell through enhanced oil recovery was good economic strategy for the company given its investment constraints, lack of geological risk, and short-time horizon (Interview Lajous 2015). However, the production boom was mostly absorbed by the Treasury in the form of taxes and duties paid by Pemex, which did not help Pemex to save resources to invest in internal capabilities and in future exploration. When Pemex reached its peak production in the years of 2003 and 2004, with total output of about 3.8 mb/d, it registered losses of \$5.9 billion. In fact, from 2003 to 2015, Pemex registered profits only in two years, 2006 (\$4.1 billion) and 2013 (\$6.4 billion), while the accumulated losses have reached \$130 billion (see Table 3.4 in the annex for selected financial indicators). Taxes of Pemex are constantly higher than the company's operating income and the difference has been covered through debt, resulting in a negative equity since 2009. By 2015 the equity was of \$-77 billion, with about half coming from pension fund liabilities, thanks to generous concessions extracted by the workers' union. In other words, almost every year Pemex had lost money in its operations and if it were to shut down and sell all its assets to cover the debt would still be negative in \$77 billion. And those negative results were achieved despite the production and price record of the recent period.

Why would the owner of a company deprive it so much of resources, thus leading it to the verge of collapse? The theory presented in this chapter expects that extraction of low-cost reservoirs maximizes rent-capture over creation. In a classical principal-agent problem, Pemex and the government have been fighting about those rents as well. As Díaz-Cayeros (2013) puts it, there is a bargaining situation between Pemex management, which knows the true cost of oil extraction, and the finance minister, who wants to extract as much rents as possible and minimize internal inefficiency and corruption costs. The government has had limited capacity to influence directly how the company is run, because of the latter's internal bureaucratic structure, its self-regulation, and the power of its workers' union (Lajous 2009). However, it controls the budget of Pemex, which is reviewed by the Treasury and approved by the Congress. Therefore, the government sets taxation levels and how much the company will retain for investments. Not only politicians will be better off in the short-run by maximizing their available rents to spend but they also operate under the assumption that Pemex is highly inefficient and could do more with less, which accounts for the high taxation levels.

To sum up, during the 1980s and throughout most of the 2000s, Pemex in the Mexican economy served first and foremost as a provider of fiscal resources to the Treasury and benefits for its own workers. An attempt to develop local suppliers through a concerted policy of import-substitution in the oil sector at the beginning of Miguel de la Madrid's tenure was short-lived. In addition to limited capital investments of Pemex after Cantarell was already in full production, the economic opening that started in 1986 with Mexico's association with the General Agreement on Tariffs and Trade (GATT, the precursor of the World Trade Organization) signaled a strong move away from active industrial policies. This would continue during the free-market leaning administration of Carlos Salinas de Gortari, who signed the NAFTA agreement and privatized many companies, but did not try to do the same with Pemex.

Figure 3.6 provides a panoramic picture of the Mexican oil industry. It displays productivity per well and the number of wells drilled since 1938. From 1938 to the mid-1970s, productivity per well had only a modest increase, from 114 barrels per day (bpd) to 200 bpd after more than 30 years. During this period, Pemex needed to keep investing if it was to increase production. Starting in 1974 and reaching a first peak in 1982 (at 864 bpd), with the development of Cantarell, Pemex reduced the investment in new wells and production went up. The second peak of productivity came in 2001, at 978 bpd, with the use of nitrogen injection in Cantarell. At this moment, Pemex once again started to drill more, but, in absence of a new prolific super giant field, and because of deficiencies in project execution (Lajous 2009), productivity declined almost as fast as it had risen in the 1970s.



Source: Pemex Statistical Yearbook (various years)

Figure 3.6: Mexico’s well drilling activity and productivity

4. When rents become scarce: the reformist era

As Cantarell started to decline after 2003, Mexico entered a period of crisis in its oil industry. The exports of the country had diversified but the state fiscal dependence on oil rents was the same as in the early 1980s (Figure 3.4). After years of underinvestment in exploration, and following a strategy of buying rather than developing technologies and expertise, Pemex’s capabilities in project management were poor. Moreover, the IMP was not ready to support Pemex in its new geological challenges, such as deep offshore exploration (Domínguez Vergara 2008). Besides, the monopoly regime prohibited Pemex from sharing the burden of high-capital investments with other private companies, as is the standard in the industry in high-risk, high-cost projects.

During the 2000s, the political reality of Mexico had changed. From 2000 to 2012, the presidency was occupied by the PAN – first with Vicente Fox (2000-2006) and then with Felipe Calderón (2006-2012) – which marked the transition to democracy after years of the PRI hegemony. Mexico’s transition to democracy was a staggered process, with gradual strengthening of opposition parties along with defections from the PRI of sectors of the civil society. A decisive step in the direction of free and fair elections was reached in 1996, when a political compromise granted independence to the Federal Electoral Institute (Greene 2007, Magaloni 2005). Since the 1997 mid-term election, Mexico has lived

with divided governments comprised of three main parties: the business-friendly PAN, the leftist PRD, and at the political center the PRI.

The negotiated nature of the transition left many legacies from the PRI hegemonic period intact, including the management structure of Pemex. Its problems started from the very top: the board of Pemex was composed of six cabinet members⁴⁰ and five union leaders. The union had a longstanding veto power and exercised control over labor conditions, shutdown of operations and even contracting suppliers. The strength of the union at a time was so high that it controlled hiring and firing practices to the point of allocating positions by inheritance or selling them (Meyer and Morales 1990). With time, some of these benefits have been moderated while others have been granted.⁴¹ What remained constant was that labor unions had strong ties to the PRI and senior management required their cooperation to run the company.⁴² In fact, since 1993 the leader of the union has been Carlos Romero Deschamps, who has held various legislative positions with the PRI, including in the federal Senate. Throughout this period, any attempt to reform the relationship between Pemex and the state was received with strong criticism (see, for example, Bartelett and Rodríguez 2008, and Real y Aguilera 2008). Part of the reason was the strong nationalistic attachment that Pemex represented and its strong political constituencies, which included support from the PRD.

In 2008, the administration of President Felipe Calderón, who had occupied the Ministry of Energy during Vicente Fox's administration, published a report that diagnosed Pemex's weaknesses and the challenges ahead (Sener 2008). Emphasizing that the resources to be developed had very different geological characteristics and comparing the development of Cantarell to resources in the deep waters of the Gulf of Mexico, it served as a harbinger of a reform attempt. Drilling time in deep offshore was calculated to be 66% longer and much costlier (at least \$100 million per well) than Cantarell. Moreover,

⁴⁰ The cabinet consists of the minister of Energy, who presides over the board, the minister of Finance, and other positions that regularly are filled by representatives from the Environment, Economy, and Public Function Ministries. The union had been in the board of the company since its creation in 1938.

⁴¹ See Loyola Díaz and Martínez Pérez (1992) for a review of Salinas's efforts to restructure the labor union of Pemex and Novelo (1991) for a history of the union and its sources of political power. Moreno (2015) provides an up to date account of the benefits received by the union in recent years and the scandals involving the union leader Romero Deschamps and his family, including the illegal use of union resources to fund a PRI presidential campaign (Pemexgate).

⁴² Frequent changes in the senior management of Pemex – following political cycles and cabinet reappointments – also had an effect on the bargaining position of the management vis-à-vis union leaders. As one of the interviewees put it, "One thing that they told me, before they said 'hi, how are you,' was 'Carlos, you are going to leave before you can start moving things. We are going to stay here forever.'" (Interview Carlos Murietta 2015). See also Muñoz Leos (2006) for an account of his tenure at Pemex (from 2000 to 2004) and his various efforts to become closer to the union.

in contrast to Cantarell, whose geological success rate was 90%, the government forecast that in deep offshore wells that rate would be a mere 15%. Pemex had zero production from deep offshore, but even from the areas that it had already developed, production costs from 2000 to 2008 increased by 40% (Pemex 2009a).

The 2008 reform aimed at increasing the ability of Pemex to tap new sources of oil and run more efficiently. It included a reform in the governance structure of the company, slightly reduced government take of the oil sector⁴³, the creation of a regulatory agency (Hydrocarbon National Commission, or CNH in the Spanish acronym), and the introduction of a profit-sharing contract, wherein Pemex could partner with oil companies to develop prospects, under very restricted conditions. For the first time, the issue of local content was brought to the hydrocarbon legislation. R&D for the sector received a major boost from a new duty of 0.65% of total oil sales which is directed to public funds managed by the Ministry of Energy and the National Science and Technology Council. The funds cover expenditures in research projects, human capital development, and IMP's activities, and they were part of a strategy to help Mexico overcome the new technological challenges of the petroleum sector (interview Ortiz 2015).

The 2008 reform moved Mexico one step closer to the "Norwegian model," wherein policy, regulatory and commercial functions are separated (Thurber et al. 2011). The Ministry of Energy was responsible for setting the energy policy with a focus on reserve replacement and production rates while CNH would issue (non-binding) opinions on Pemex's development plans. CNH also served to reduce the information asymmetry between Pemex and the rest of the industry stakeholders by analyzing and publicly evaluating Pemex's exploration and development projects and by publishing technical documents (see, for example, CNH 2010a and CNH 2010b). Previously, the Mexican oil sector was managed with almost total independence by Pemex, with a weak regulatory oversight by the Ministry of Energy and budget control by the Ministry of Finance (Stojanovski 2012).

Despite the intentions and efforts put by the PAN administration, the reform was ultimately considered a failure (Lajous 2014). The formula for the risk contract, for instance, had an unbalanced distribution of risks and profits, with partners bearing all the risks (Interview García Alcocer 2015). The most fundamental reason for the failure was that the initiative did not even attempt to touch the

⁴³ The Ordinary Duty on Hydrocarbons, the most important tax of the sector, was reduced from 79% to 71.5%, but a duty for R&D of 0.65% was established. Pemex also was allowed to have a higher cost deduction for two areas: Chicontepec and deepwater fields, from the regular \$6.50 to \$11 and \$16, respectively.

constitutional articles that guaranteed the monopoly of Pemex. Negotiators from PRI made it clear that they would not accept any reform that included constitutional changes, and no reform could be approved without their consent. Therefore, the proposal from the executive was considered to be “born dead” (Interviews Camarillo 2015, Reyes Heróles-Garza 2015). Complicating matters further was a lack of cooperation from PRI and PRD while PAN was in power (Haber et al. 2008, Casar 2013) and infighting within the government. Moreover, Felipe Calderón became president in a contested election that severely limited his initiatives: he received 35.89% of the popular votes, which gave him less than 1 percentage point of margin in relation to the leftist López Obrador (PRD), who challenged the result. Calderón lacked the political power to put together a coalition to reform the natural resource sector, and the PRI and PRD vetoed deep changes.

What the government could do was to authorize Pemex to increase its investment budget, and it did so mostly through debt. The company directed its resources to the core revenue generation segment, exploration and production (E&P), reducing the total share of capital investments in refining and petrochemical. E&P investments increased in real terms more than three-fold. However, as shown in Table 3.2, on average, 87% of the E&P resources were dedicated to exploitation, such as drilling new development wells to extract from areas of proved reserves, which generates cash in the short-run. Exploration, which when successful builds reserves for the future, had in absolute values a much more modest growth. Political incentives matter to explain this behavior: investment in exploitation generates short-term payback while exploration, particularly in deep offshore areas, can only generate rents for a future administration.⁴⁴

The PRI president-elect in 2012 was in a better position to initiate a reform: Enrique Peña Nieto amassed 38.2% of the votes and a margin of over 6 percentage points over the same López Obrador. He had much higher political capital than his predecessor, but after years of inaction, so was the incoming energy crisis. High investments in exploitation and unsuccessful exploration efforts accelerated the rate at which Pemex drained its reserves, and this led them to critical levels.

⁴⁴ Juan Carlos Zepeda, an economist who has headed CNH since its creation in 2009 (later reappointed by Peña Nieto’s administration with Senate confirmation) and who worked previously at the Ministry of Finance evaluating Pemex’s investment projects, shares the view that the then-existent legal framework did not provide the right incentives for long-term investments. The legal restrictions of Pemex and the political pressures that it faced were simply not compatible with a perspective of creating value with a long-term perspective, and the 2008 Energy Reform was not able to change this (Interview Zepeda 2015). Notwithstanding this failure, he credits the Calderón administration with bringing the issue to the table, initiating a politically difficult discussion in Mexico.

Table 3.2: Pemex's capital investments in billions of 2014 US dollars

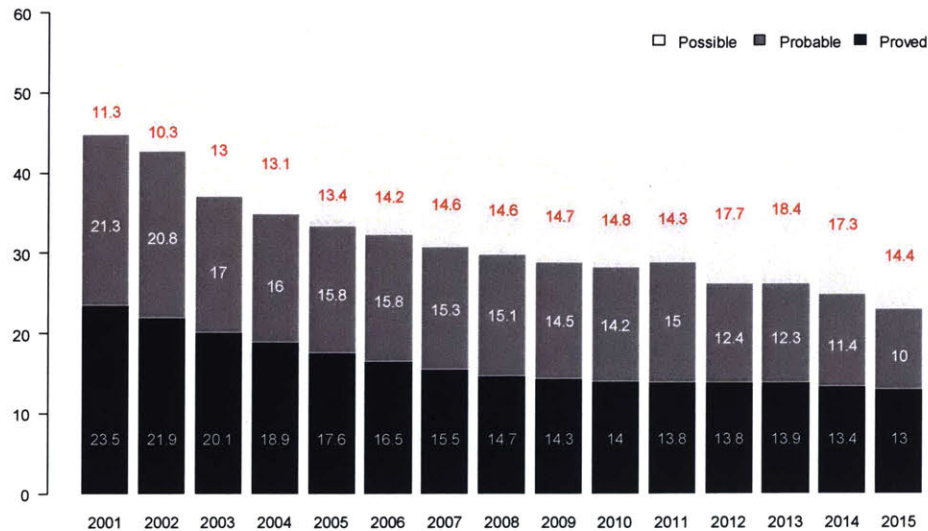
Year	Exploration	Exploitation	Total E&P	Share E&P	Others	Total
1997	0.588	3.822	4.41	69.77%	1.911	6.321
1998	0.725	4.35	5.075	76.09%	1.595	6.67
1999	0.568	4.544	5.112	78.26%	1.42	6.532
2000	0.548	5.069	5.617	63.08%	3.288	8.905
2001	0.536	6.03	6.566	84.48%	1.206	7.772
2002	1.188	6.468	7.656	78.38%	2.112	9.768
2003	2.064	8.514	10.578	78.10%	2.967	13.545
2004	2.5	10	12.5	91.74%	1.125	13.625
2005	1.694	10.769	12.463	88.03%	1.694	14.157
2006	1.404	12.519	13.923	86.23%	2.223	16.146
2007	1.368	14.136	15.504	87.18%	2.28	17.784
2008	2.42	15.18	17.6	88.40%	2.31	19.91
2009	2.42	16.06	18.48	90.32%	1.98	20.46
2010	2.507	18.203	20.71	89.62%	2.398	23.108
2011	2.625	17.325	19.95	88.37%	2.625	22.575
2012	2.575	18.746	21.321	88.09%	2.884	24.205
2013	2.55	20.4	22.95	86.21%	3.672	26.622
2014	2.6	20.8	23.4	84.48%	4.3	27.7

Source: Author's calculation based on data from Sener.

4.1. Old geological challenges in a new administration

By December 1, 2012, when Enrique Peña Nieto (PRI) took office as Mexico's 57th president, the proved reserves of Pemex were sufficient for just ten more years of production.⁴⁵ The trend was even more frightening. The reserve replacement rate, an indicator of how much reserves were added in a year discounted what was produced in the same period, had been consistently negative (see Figure 3.7). With the exception of two years, 2012 and 2013, Pemex was producing by depleting its proved reserves.

⁴⁵ Exploitable oil reserves are determined by a complex combination of technology, price, and politics (Inkpen and Moffett 2011). The industry classifies reserves in three main categories: proved, probable and possible. Proved reserves are those that have a 90% certainty of commercial extraction at current technology and prices. They are also known as 1P. Probable reserves, or 2P, are those that have a 50% certainty of commercial extraction while possible reserves (3P) are those that have at least a 10% chance of being put into production under current conditions. Any identifiable hydrocarbon formation that has less than a 10% chance of commercial extraction will be referred as contingent resources or recoverable resources.



Source: Pemex Hydrocarbon Reserves Report (various years)

Figure 3.7: Mexico's O&G reserves (in billions of barrels)

To make matters worse, prospective resources that could be added to reserves were mostly located in high-cost and technically challenging areas: the tight oil formation of Chicontepec, the deep offshore on Gulf of Mexico and the shale resources of Tampico-Misantla and the Burgos Basin, which is an extension of the Texas' Eagle Ford deposit (see Figures 3.11 and 3.12 in the annex for Pemex's estimation of their cost of development).

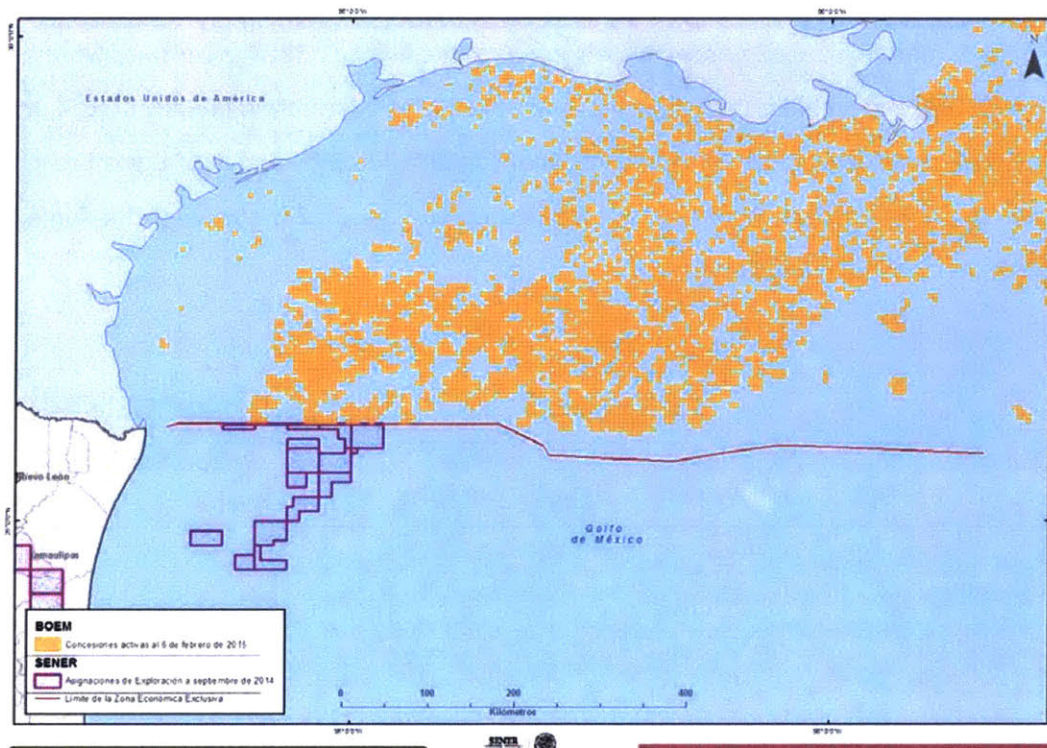
Table 3.3: Mexico's oil resources (in billions of BOE)

Basin	Accumulated production	Reserves			Prospective resources	
		1P	2P	3P	Conventional	Unconventional
Sureste	44.5	11.8	17	23.4	16.8	
Tampico-Misantla	7.1	1.1	6.6	15.7	2.4	34.8
Burgos	2.3	0.3	0.5	0.7	3	10.8
Veracruz	0.7	0.2	0.2	0.3	1.4	0.6
Sabinas	0.1	0	0	0.1	0.4	14
Deep waters	0	0.1	0.4	1.9	27.1	
Yucatán	0				1.5	
Total	54.7	13.5	24.7	42.1	52.6	60.2

Source: Pemex, reserves and prospective resources at January 1st 2014

A quarter of Mexico’s prospective resources are in deep waters and over half (53%) are in unconventional formations (see Table 3.3). As of 2015, Pemex had zero production from deep waters and very limited experience in exploration in this segment; its first well was drilled in 2004. The most promising area in the Mexican side of the Gulf of Mexico is the ultra-deep offshore region close to the US border. However, as shown in Figure 3.8, the difference between 2014 active concessions in the US side with exploration areas of Pemex in its side of the border indicates how far Mexico’s oil company has fallen behind its competitors.

As addressed in Section 2, deep offshore (over 400m of water depth) exploration has markedly different characteristics than conventional onshore or shallow water projects: it requires more capital investment (Kaiser and Snyder 2013), takes more time to drill and complete a well, and involves high operational risks, leading companies to pool resources rather than go it alone (Raymond and Leffler 2006). In the Mexican case, Pemex, which was a latecomer to deep offshore development, had neither the know-how nor the possibility of spreading risks with partners because regulations prohibited other companies from being paid with oil rents in Mexico.



Source: Sener

Figure 3.8: Oil and gas leases in the Gulf of Mexico

By 2012, Pemex's technological limit of production was wells located in 100m water depths. Since 2004, the firm made a bet in deep water exploration with disappointing results. Of the 28 deep-offshore drillings made by Pemex between 2004 and 2012, 16 failed completely and 12 (42%) had very timid results; they mostly added to possible reserves (3P) of natural gas and heavy crude (Barbosa Cano 2012).⁴⁶ Lajous (2014) concludes that of the 15 costly drillings made by Pemex before 2010, only one field, Lakach, had significant reserves and commercial viability. Located at 988 m water depth and about 100 km from Veracruz, Lakach was discovered in 2006 and by 2016 it was still under development, without any production. These results were not surprising given the diagnosis made by the Ministry of Energy in 2008 (Sener 2008).

Acknowledging that deep offshore resources would take time to develop – if found at all – Pemex's management by the second half of the 2000s proposed a massive drilling campaign in the Chicontepec area to compensate for the decline of Cantarell and to serve as a bridge before the start of production from the Gulf of Mexico. Chicontepec (later renamed to *Proyecto Aceite Terciario del Golfo - PATG*) is an onshore resource-rich area of the Tampico-Misantla basin in the states of Veracruz and Puebla. It has been known since 1926 but production had been very limited. Original oil in place was estimated to be 136 billion barrels, making it Mexico's largest resource area (CNH 2010b). However, Chicontepec is a technically challenging asset that has low permeability and unconnected reservoirs. There is plenty of oil, but it is hard to get: it is stuck in isolated pockets. Its extraction requires either massive conventional drilling to output a limited number of barrels or the use of techniques found in unconventional production, such as hydraulic fracturing and horizontal drilling, to increase recovery factors. Another alternative is to start production using secondary recovery methods such as water flooding and enhanced oil recovery techniques such as gas injection, which normally are used in mature fields to increase reservoir pressure.

Pemex's plan was to drill 1000 new wells a year to reach, by 2021, 600 kbpd (Sener 2008). Chicontepec absorbed a large part of the increase of the exploitation budget depicted in Table 3.2. However, production at its peak never went beyond 68 kbpd (in 2012) and the original plan was revised to account for delays in putting in place the necessary infrastructure and production failures. CNH (2010b) and Lajous (2014) criticized Pemex's rush to drill in Chicontepec and present production targets

⁴⁶ Pemex's campaign in shallow waters also has not been promising. Mostly small fields were discovered and many contain natural gas or extra heavy crude – both characteristics that have relatively low market value and require significant infrastructure (Barbosa Cano 2012).

before it could characterize the subsoil, choose the most appropriate techniques and execute following best-practices in order to minimize production costs and avoid damage to the fields.⁴⁷

Just as drilling in Cantarell provides a perfect contrast with the challenges of exploring deep offshore, producing from Chicontepec compared to Mexico's most prolific field highlights another type of geological challenge: reservoir recovery factor. While Cantarell, a naturally fractured reservoir, had a recovery rate of 35.2%, Chicontepec had a rate of about 1% (CNH 2010a). In other words, in Cantarell Pemex had been able to recover 35.2% of the oil in place, but in Chicontepec it had been leaving behind 99% of it. Given its repeated failure to produce from Chicontepec, Pemex in 2011 was forced to decrease the possible (3P) reserves of the area from an estimated 9.1 billion barrels to 2.2 billion barrels (CNH 2011). In a high-cost basin such as Chicontepec, which resembles unconventional reservoirs, operational efficiency and fast learning is highly important (Aguilera and Radetzki 2015, Zuckerman 2013).

Both deep offshore and unconventional resources proved to be very challenging for Pemex to develop – but that is where future oil resources in Mexico are located. Although these are all high-cost areas, the rules in place and the political incentives were aligned for high-rent capture and short-term incentives. The failures in deep offshore exploration and production from Chicontepec were a strong indication that the Mexican oil industry would need more than just reducing the government take and increasing Pemex's exploratory budget. It also needed to attract and develop technology and operate under rules that would align incentives for long-term planning and share the geological risk and oil wealth with private oil companies.

Peña Nieto took office with an ambitious package of ten structural reforms that he negotiated with the main parties and labelled them as "Pact for Mexico." Mexico's political system is characterized by high party discipline (Casar 2013). Thus reforms sink or swim on the basis of negotiations with the party leadership rather than through the individual support of lawmakers. The energy reform proved to be the hardest one to pass: the PRD decided in block to vote against it, leaving PAN with veto power over the proposal. As a constitutional reform, it required a two-thirds majority to be approved. It passed in the lower chamber with 73% of the votes, which was the lowest voting support within the

⁴⁷ Pemex in fact later changed its strategy from indiscriminate massive drilling to assign laboratory fields to contractors such as Schlumberger and other oilfield service companies to experiment drilling techniques and production systems – but denied access to IMP. See Lajous 2014.

constitutional reforms proposed by Peña Nieto (Leyva 2015).⁴⁸ PAN's pivotal position explains why the approved reform was even more liberalizing than what the executive initially proposed. Among the changes pushed by PAN were the removal of the PRI-linked union from the board of Pemex and adding the much maligned in Mexican history licensing contracts (Grunstein 2010) to the roll of available contractual instruments between the state and oil companies. Below, I discuss how the 2013 energy reform addressed three key areas: rules of access to resources and the regulatory framework; rent-taking by the state; and industrial and technology policies (local content). I show how these were shaped by the new geological challenges faced by the Mexican oil industry and the political constraints faced by the executive in negotiating with policymakers. The changes are summarized in Table 3.5 in the annex.

4.2. Rules of access to resources and the regulatory framework

The energy reform radically transformed the governance of the oil sector by redistributing roles of stakeholders and enlarging the number of actors involved. Moving from a model of one operator to multiple companies implied strengthening the regulatory role of the state, putting in place a process through which areas would be granted to oil companies, and reforming Pemex to compete with major players.

In terms of regulations, the reform strengthened the roles of CNH and created a new agency to regulate operational safety and environmental performance (ASEA).⁴⁹ Created by the 2008 reform, CNH was previously only responsible for issuing opinions on reserve development projects (but could not veto) and publishing the country's reserves. In the 2013 energy reform, the organism was given budget autonomy, and the responsibility to conduct bidding rounds and write the technical standards in terms of operational practices, aiming at increasing recovery factors and maximizing the long-term recovery of the fields over short-term exploitation. The number of commissioners was increased from five to seven. The mode of appointment of commissioners changed from direct selection by the president to a list of three candidates that has to be approved by a two-thirds majority of the Senate. The mandate, originally five years, was increased to seven, going beyond the regular six year presidential mandate. Pending

⁴⁸ The other constitutional reforms had the following voting record in the lower chamber: education (81.52%), telecommunications (92.32%), political (85%), and transparency (95.39%) (Leyva 2015).

⁴⁹ National Agency of Industrial Safety and Environmental Protection of the Oil Sector (ASEA from the Spanish acronym). Policymakers opted for this model following the Deepwater Horizon oil spill, in response to which experts concluded that there is a potential for a conflict of interest when the same regulatory institution is responsible for oil production and for overseeing environmental standards.

unforeseen circumstances, no president will be able to select all commissioners since there are seven of them and their end terms are staggered: each year only one should be up for selection.

The Ministry of Energy was put in charge of developing the national energy policy and objectives, with a longer time horizon. This includes publishing a five-year plan for putting into bid, each year, new hydrocarbon areas. The objective is to provide a predictable business environment for investors and increase total reserves and production over time. The first five-year plan, undertaken through a process started at the Ministry of Energy with geological information obtained from CNH, was made public on June 30, 2015. The document was released to stakeholders for public consultation, which allowed the government to receive information from the private sector and local governments. Policymakers then adjusted parameters of exploratory areas to blocks of larger sizes and with better existing seismic studies, and published a revised plan three months later (Sener 2015).

The reform transformed Pemex's legal regime into a new model called State Productive Enterprise, which increased the company's flexibility. Previously, Pemex had functioned as a government entity, subject to all controls and rigidities of government procurement and wage structures, including salary limits that would make working for Pemex less attractive for senior management than positions in the private sector.

A major change was the removal of the five union members from the board of the company. This was an imposition made by the PAN during the legislative negotiations and that the PRI was forced to accept, despite strong opposition from Carlos Romero Deschamps, the leader of the workers' union and a PRI sitting senator at the time of the reform. During reform negotiations, the PRI attempted to keep union members as part of the board with voice but no voting rights, but the PAN refused the compromise. The board is now composed of five cabinet members and five professional independent board members.⁵⁰ The law also created incentives for Pemex to renegotiate pension liabilities with the union, which by the end of 2015 included migration to individual accounts for younger employees and increases in the minimum retirement age (Reuters 2015). It also started a painful adjustment to

⁵⁰ The 2008 Energy Reform also introduced changes to the board of the company by adding four members selected by the president with Senate confirmation, totaling fifteen positions in an attempt to dilute the power of the union. However, those four members had to be civil servants (a limitation that has been lifted) and the positions had been shared by the main parties, with PAN retaining two of them and the other two split between PRI and PRD. The first round of five appointments did not follow party lines (Interviews Elizondo 2015 and Camarillo 2015).

competition and reduced total payroll by 15 thousand workers from 2014 to 2015, more than 10% of the workforce, in an unprecedented move in the recent history (see Figure 3.13 in the annex).

For the country to offer exploratory areas for new operators, Pemex had to relinquish some of its exploratory areas (a process known as Round 0) and to commit to a timeframe to explore and develop the resources that it held. The government granted Pemex the right to keep 83% of its probable (2P) reserves (Pemex 2015a), including deep-water reserves that it has yet to confirm and develop. The reform gives Pemex the option to partner with private companies to jointly develop resources or sell areas (farm-out). While the reform radically transformed the rules of access to resources and the regulatory apparatus, Pemex continues to be a whole-owned entity of the state, with most board members directly selected by the executive (with exception of the independent board members). Contrary to what has happened to Ecopetrol (Colombia), Petrobras (Brazil), Petrochina (China), and Statoil (Norway), which are all state companies that have shares quoted in national and international stock exchanges (Tordo et al. 2011), and in moves that were taken to facilitate access to capital and enhance accountability, Pemex continues to have a closed capital structure. It gained managerial flexibility and a tax regime that will be competitive with other companies operating in Mexico, but it inherits a structure that is anything but lean.⁵¹

Summarizing, the energy reform touched all relevant aspects of the rules of access to resources and the sector's regulatory apparatus. By empowering an independent organization headed by members approved by a super majority of the parties, the Mexican state signaled that regulations will follow technical requirements rather than political convenience. The long tenure and staged appointment of commissioners also secures the stability of rules. The fact that CNH conducts the bidding rounds increases the legitimacy and credibility of the process because those responsible for awarding the assets (the exploratory blocks) are not political appointees. These changes are particularly relevant for projects that have long-lead times and asset specificity, such as deep offshore exploration, and they are in line with theory predictions.

⁵¹ Those who bet on the success of the reform to Pemex believe that competitive pressure will finally facilitate internal reforms, which previously had been blocked internally. However, it is insufficient clear if competition alone will be sufficient to reverse the inertia within the company. Even interviewees who expressed strong support for the reform cast doubts on the capacity of Pemex to quickly adapt to a competitive environment. For instance, Reyes-Heroles (Interview 2015), who claimed that Pemex needed the reform, stated that he is the living proof that one could not change the company from within. He was concerned that the management of the company (at the time of the interview) did not grasp the magnitude and strength of the changes needed. Likewise, Zepeda (Interview 2015) highlighted that Pemex lacks the corporate structure of companies like Petrobras and Statoil.

The Ministry of Energy strengthened its domain in policy setting and planning. Consulting with the private sector helps to adjust future bidding offers and facilitates the attraction of a continuous flow of investments necessary to build reserves. Finally, while Pemex continued to be whole-owned by the state, it gained in managerial flexibility and reduced the rent-taking by the workers' union – despite their political power. The firm is downsizing and the union was removed from the board of the company and agreed to a pension reform that increased retirement ages and introduced an individual account scheme.

4.3. Rent-taking: adjusting rents to investment opportunities

Potential oil resources that have high geological risk, investment, and operational costs will be left undeveloped if taxation is set at high levels. The theory developed in this dissertation predicts that the development of high-cost resources will be facilitated by adjusting rent-taking to the particular geological characteristics of each asset. Accordingly, the latest energy reform introduced bidding rounds to exploration areas, wherein government take will depend on the minimum requested by the state and the appetite of investors for the specific geological attractiveness of each block.⁵² Unless there is a match between the expectations of profitability of oil companies and the government's appetite for rents, the auction will fail.

This is a major departure from the model that previously prevailed, where the state would guarantee its share of rents first rather than the profitability of its company and the investment levels needed to replace reserves (Tordo et al. 2011). Pemex could achieve production records and yet register losses because the taxes and duties paid by the company were charged on total production and not on profits per field. For instance, the fiscal regime before the 2013 Energy Reform recognized production costs of \$6.50 that Pemex could use to reduce from its total taxes, \$11 for production from Chicontepec, and \$16 from future deepwater production. Assets like Litoral Tabasco, Ku-Maloob-Zap, Abkatún-Pol-Chuc, all shallow water fields, had production costs below \$6.50 and generated revenues to the company (they ranged from \$4.18 to \$5.71 in 2013).⁵³ Other assets, like PATG-Chicontepec and Poza

⁵² In contractual terms, the reform authorized the state to enter into all of the major contractual forms that prevail in the oil business, excluding concessions: service contracts, production-sharing, profit-sharing, and license. Consequently, the state has the flexibility to match specific block characteristics to a range of contractual forms.

⁵³ See also figures 3.11 and 3.12 in the annex, which are taken from a Pemex presentation to lawmakers during the energy reform debates. They show that new investments had a much higher cost of production and required

Rica-Altamira showed production costs more than three times those of the more prolific shallow water fields and Pemex was losing money from each barrel it produced from these fields. Because production costs from those more expensive fields were still below the international price of oil, a surplus was being made. However, it was entirely captured by the Mexican state. Not only was the fiscal regime stripping Pemex from reinvestment opportunities, it was actually discouraging risk-taking into frontier, more costly, areas.

If Pemex were managed like a regular business, production from fields that after taxes result in negative income would be shut down. Total oil production of Mexico would decrease but the profitability of the company would go up. This situation generates conflicting incentives between the principal (the Mexican state) and the agent (Pemex), as business as usual is negative to Pemex but profitable to the state (a situation that is not sustainable in the long-run). Top managers, who are political appointees, would constantly cite in interviews that they were judged by volumetric targets and not by company profitability.⁵⁴

The state preference for rents – and the impact of recent changes – is also clear from an analysis of the amount of taxes over total sales of Pemex over time. The company has frequently paid 60% of its revenues to the government (see Figure 3.9).⁵⁵ Average government taxation has been in decline since 2008 and it was markedly lower in 2015, which was the first year after the reform was fully approved. Until the most recent period, taxation levels had no relationship to the price of oil – the Mexican government would extract about the same share from Pemex regardless of price windfalls. By auctioning areas, the new model solves this mismatch of incentives by requiring the state to entice companies to invest; this calls for a cost-benefit analysis of the prospective areas by the firms (Bhattacharyya 2011).

higher cost deductions to be produced profitably. Some areas, like shale, would not be profitable even in the absence of taxes if oil prices are \$50 or below.

⁵⁴ In fact, in its 2016-2020 business plan, Pemex publicly recognized that the company had been subject to a rentier model that had no relation to the firm's profitability levels and volumetric targets set by the government, which forced production from unprofitable areas (Pemex 2015b).

⁵⁵ In contrast, the tax burden of Pemex from 1938 to 1976 ranged from a minimum of 7.9% to a maximum of 22.7% (SPP 1980 p. 413).

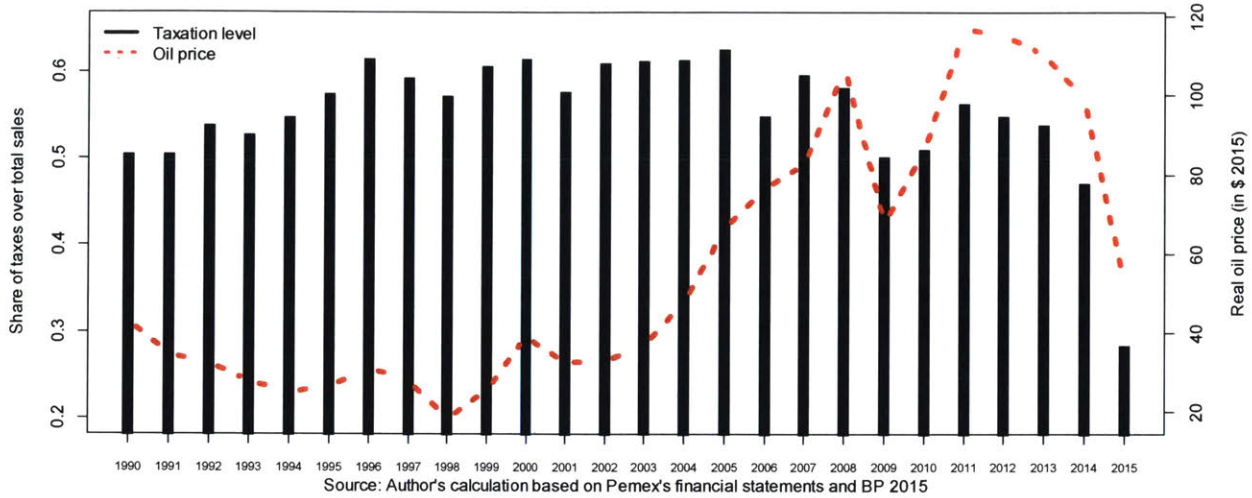


Figure 3.9: Taxation of Pemex and oil price over time

Revenues from the oil sector will now go to the Mexican Petroleum Fund for Stabilization and Development, administered by the Central Bank of Mexico, which is one of Mexico's pockets of efficiency in the public administration and formally independent from the executive. The fund was not designed to eliminate the high dependency of the government on oil rents, but it provides a cap to it. Revenues up to 4.7% of the GDP are returned to the budget of the executive, while income above that threshold is saved for the long term. "It is a compromise. It is not a perfect oil framework as the Norwegian but an intermediate framework from literally spending all oil revenues as they are collected," justified the Undersecretary of Revenues Miguel Messmacher (Interview Messmacher Linartas 2015), who is one of the drafters of the reform. The lower oil rents scenario also pushed the PRI administration to approve a fiscal reform that is projected to increase tax collection by 2.5 percentage points of the GDP, from the low base of 10% (Messmacher Linartas 2014).

4.4. Industrial and technology policies (local content)

As the investment necessary to bring a barrel of oil out of the ground grows per unit of output, the rent each barrel generates decreases but the capital and operational expenditures go up. Because of the sovereign ownership of subsoil rights, governments determine the rules of access to reserves, which

can include regulatory provisions to maximize purchases from local companies (Tordo et al. 2013). The theory developed in Chapter 2, and previously summarized, predicts that the development of high-cost oil triggers distributive pressures in the form of contracts to the large upstream production chain (local content) and in cost-reduction investments, which will include R&D and worker’s training programs.

I document first the trend towards cost increases in Mexico. Production costs tend to rise as one moves away from producing (a) from a few prolific fields to many smaller fields, as economies of scale are lost; and (b) from conventional to deep offshore, tar sands, and shale reservoirs. Using field data for Mexico between 1960 and 2015, I computed a normalized Herfindahl-Hirschman Index (HHI) to measure the concentration of oil production of Mexico over time (Figure 3.10). The data reveal a drastic loss of economies of scale: using standard measures of market concentration (US DOJ 2010), Mexico went from a highly concentrated market (with HHI above 0.25) to a deconcentrated market (below 0.15) in less than a decade.⁵⁶ The peak of concentration was reached in 2004 with 0.36 HHI, when the Akal field, the most important of the Cantarell complex (Romo 2015) alone was responsible for 60% of Mexican oil production. After the peak, field concentration underwent a drastic decline and reached a low of 0.048 HHI in 2013.

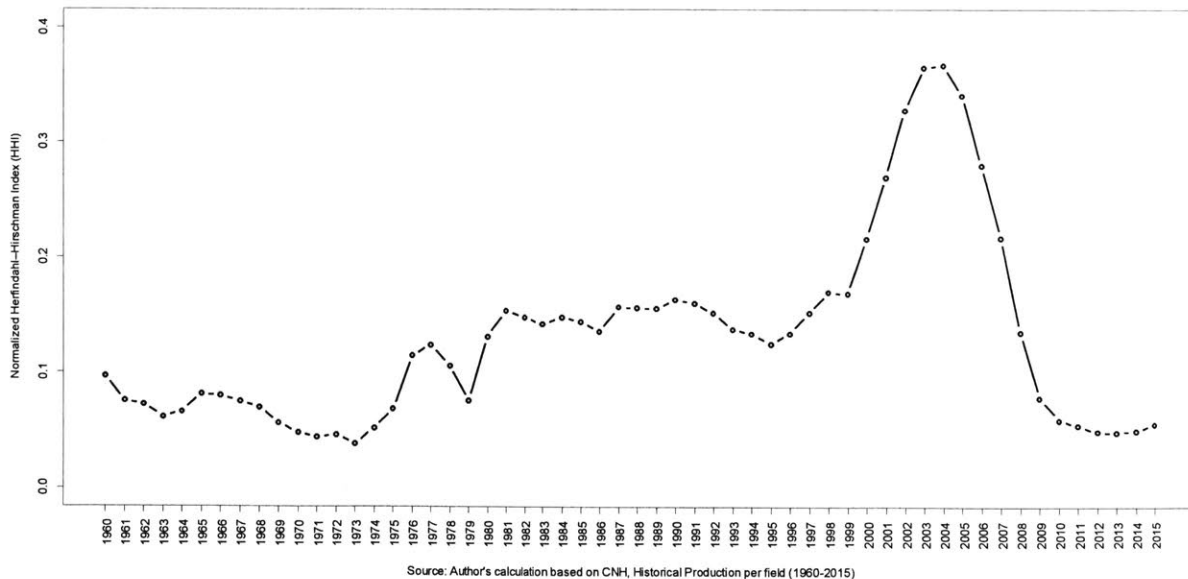


Figure 3.10: Herfindahl–Hirschman Index (HHI) applied to oil field production

⁵⁶ The HHI is calculated by summing the squares of the individual fields’ share of total output. Normalizing the HHI bounds the index from 0 to 1 and makes it intuitive to interpret: a monopolistic market, where all oil comes from a single field, results in 1 while a perfectly distributed market, where each field has the same output and therefore the same market share, is 0.

Direct evidence of the increase in production costs is supplied by Pemex itself. Direct production costs in the oil industry are “exceedingly hard to find and document” (Aguilera and Radetzki 2015, p. 37) and published numbers tend to reflect averages by companies (EY 2014) or by country and type of resource (IEA 2015), with costs by field kept as a proprietary information. Pemex made their costs per asset publicly available in congressional hearings that were part of the negotiations with policymakers over energy reform (see figures 3.11 and 3.12 in the annex). The disclosure was part of a strategy to persuade the government and lawmakers that low-cost oil resources were getting more and more scarce and the reserves to be developed would require better fiscal terms and more capital investments and technology (Interview Beauregard 2015). The Pemex data shows, for instance, that in 2006 a barrel from Cantarell had a cost of \$5.24, but in 2014 its cost had risen to \$28. Costs had increased across Pemex’s fields as a result of the depletion of existing fields (reduction of output) and migration to costlier, more complex, reservoirs. This is also clear from the investment increases in exploitation and exploration (Table 3.2) and in productivity per well (Figure 3.6).

After establishing that production costs increased in Mexico, I make the case that this issue became politically relevant and that lawmakers and business associations pressured for local content legislation – to grab a bite, by legislation, of the growing share of value to be found in oil contracts.

Targets for local content were first put into the agenda during the 2008 Energy Reform. Following other resource-rich countries (Tordo et al. 2013), legislators favored policies that mandate that oil companies commit to purchase a share of goods and services performed by local firms. A group of legislators traveled to countries that practiced local content in oil and gas, such as Brazil, Norway, and Malaysia, and studied the practices of those countries regarding local content promotion. Lawmakers then introduced the transitory article number 13th to the amended Pemex’s Law approved in 2008. The law tasked Pemex to, within 180 days, measure its local content contribution to the economy and develop a strategy so that the public company could increase its local purchases by 25% over time, giving preference to small and medium-sized firms. Pemex created a local content development unit and met the deadline by publishing a document that summarized a new procurement strategy. The document acknowledged that the costs of production were going up at Pemex because of the depletion of lower-cost fields, and it forecasted that local content promotion would compensate the decline in rents per barrel with more industrial demand, which hopefully would result in more local taxes and, over the long term, in a more competitive industry (Pemex 2009b, p. 7). Pemex also worked in

partnership with the National Chamber for the Manufacturing Industry (Canacintra) to develop sectoral studies of its demand for particular goods and the domestic supply capacity. The strategy, however, faced internal opposition from the rank and file of Pemex and, with time, it was discontinued.⁵⁷ Since the law did not establish outside monitoring of the targets or penalties for lack of compliance, it was not hard for Pemex to escape from it. Furthermore, as a legal monopoly, Pemex was not in danger of losing the operation of fields if it ignored this aspect of the law.

In 2013, local content became one of the most heated issues of the legislative debates on energy reform. To many, local content was the national flag to hold against the charge that the oil sector would denationalize with the opening for foreign companies. For instance, the negotiator from the PAN side, then deputy Ruben Camarillo, justified the move saying that it would be a failure and treason to the nation to replace the monopoly of Pemex with an oligopoly of international oil companies without benefiting the small and medium Mexican enterprises (Interview Camarillo 2015).⁵⁸

The most controversial component was setting a specific target for local content. Higher targets would signal more benefits to suppliers, which was politically important for representatives of business associations. However, this conflicted with the preferences of the executive, which had an interest in sustaining production levels and attracting new investors. If oil companies were forced to buy high shares of uncompetitive Mexican goods and services, the cost of production would rise even higher, negatively affecting the success rate of bidding rounds and the government take. In the Mexican case, this was particularly critical as Pemex had historically neglected the issue of developing local suppliers, and so the baseline was low.⁵⁹

The result was a compromise based on Mexico's current capabilities in the supply chain and the desire of politicians.⁶⁰ For onshore and shallow waters, an amendment made by the Senate to the

⁵⁷ After the initial drive to fulfill the 180 days deadline set by the 2008 law, the initiative suffered from administrative changes within Pemex, a lack of a sense of urgency, and tacit opposition. Significantly, the biggest internal support came from board members who, following the 2008 reform, had been appointed by political parties (Interviews Camarillo 2015, Diaz 2015, Murietta 2015, Reyes Heróles-Garza 2015).

⁵⁸ A petroleum engineer by training and former employee of Pemex and IMP, Camarillo was also one of the negotiators of the 2008 energy reform when he was a senator from the state of Aguascalientes. He has been a member of the Confederation of Employers of the Mexican Republic (Coparmex), one of Mexico's most important business chambers.

⁵⁹ In 2009, Pemex estimated an average local content of 35.1%. However, the methodology used could greatly overestimate the effective value added in Mexico because it counted as 100% Mexican any good whose components were at least 50% Mexican (Pemex 2009b).

⁶⁰ "The debate centered on the issue of the target and it was one of the last issues to be settled and one of the hardest ones... We did not want a high target that would imply a cost overrun," recalled Guillermo Garcia Alcocer,

Hydrocarbon Law (Article 46) mandated that LC levels reach an average of 35% by 2025, up from a base of 25% that was the executive's original proposal.⁶¹ For deep offshore, where Mexico had zero production, legislators accepted that the target would be set by the Ministry of Economy after a survey of domestic supply capabilities, to be revised after five years. The Hydrocarbon law also included an article (125) entirely dedicated to the promotion of the national industry, which includes setting up a national registry of providers, a public fund for supplier development, and measures to close capability gaps and facilitate joint-ventures between Mexican companies and foreign suppliers.

The requirement to survey the supply chain industrial capacity and the mandate to increase productive capabilities over time reengaged the Mexican state in industrial policy. In this process, it had to relearn how to do the targeted promotion of a sector and confront gaps emanating from limited state capacity in this area, lack of embeddedness (Evans 1995) and competing pressures from suppliers and oil companies. First it had to determine what was achievable to do in terms of LC and then create instruments to reach such targets. The Ministry of Economy established a forum that gathers different stakeholders and discusses current challenges and policy alternatives for developing suppliers and scientific capabilities in the oil sector.⁶² Oil companies that established offices in Mexico quickly formed an association (AMEXHI) that creates an institutional channel to negotiate with government officials; it presents the views of the sector and not of particular companies.⁶³ Traditional business chambers, like Coparmex and Canacindra, strengthened their contacts with the government and participated in meetings related to local content promotion (Interview Acra 2015). By late 2015, the Ministry of Economy, after formal consultation with the Ministry of Energy, set the target for the first bidding round of deepwater blocks to be between 3% to 8% during the exploration phase, and 4% to 10% in the development phase. Notwithstanding the relatively low targets, oil companies expressed an interest of

who participated in the crafting and negotiation of the reform as part of the Ministry of Energy (Interview Garcia Alcocer 2015).

⁶¹ The law also deferred to the Ministry of Economy to set up the measurement methodology. The Ministry later defined a simple formula, which is the sum of local expenditures made in goods, services, labor, training, technology transfer and infrastructure divided by the total expenditures. The Mexican formula for local content is neutral and diverges radically from the detailed and centered on goods and services that Brazil employs (see Chapter 4).

⁶² The Advisory Council for the Promotion of the Oil Industry, as required by article 125 of the Hydrocarbon Law (2014). Consultation forums are key components of contemporary industrial policy (see Schneider 2015).

⁶³ The Mexican Association of O&G Companies (AMEXHI, from the Spanish acronym) was founded in February of 2015, and by June 2016 it had 47 members from 18 different countries, including majors and NOCs like Petrobras, Ecopetrol, Petronas, Lukoil, and Statoil.

having the government shoulder some of the costs of developing suppliers in order to help their competitiveness.⁶⁴

The reform maintained a 0.65% funding for R&D, originally introduced by the 2008 reform, and it brought changes to the role of research institutions in the oil sector. IMP was officially detached from Pemex and will now be open to partnerships with all oil companies that come to Mexico and suppliers, strengthening its role as a national lab for petroleum. The local content formula was designed in a way that can help IMP and other research institutions since investments in technology will count in the formula for reaching the regulatory target.

With IMP out of its direct influence and the prospect of facing domestic competition, Pemex reevaluated its previous technology strategy (Pemex 2012). It prioritized areas in which it aims to (a) develop expertise and become a leader, such as enhanced oil recovery of naturally fractured reservoirs and extra-heavy crude offshore production; and (b) adapt for local conditions, such as production from deep offshore and unconventional resources. For all other goods and services, it wants to become a “smart buyer.” To achieve these objectives, the company planned to pursue partnerships with universities, IMP, other oil operators and joint ventures (Interview Silva 2015).

As a process under implementation, it would be speculative to forecast how the energy reform will affect the future of many of the industry pillars, particularly Pemex, IMP and the local supply chain. What is immediately clear is that the reform profoundly rearranged roles and responsibilities within the sector. These include (a) the creation of a new fund for R&D; (b) the introduction of new stakeholders to oil policymaking (CNH, private oil companies, business chambers, etc.); (c) the expansion of the time horizon in energy planning and contracting; (d) the reduction of rent-capture by the state; (e) the bargaining by the government over local content targets; and (f) the reengagement of the Mexican state in industrial policy. For a sector that had operated under the same basic rules since 1938, when Lázaro Cárdenas expropriated foreign oil companies and created Pemex, the level of change in a short time span is close to revolutionary.

⁶⁴ Although executives from oil companies frequently pointed out that having good (certified) and cost-competitive suppliers next to their operation is very welcome, they tended to be critical of setting up ambitious and specific targets. Both industry executives and government officials cited as something to avoid Brazil’s experience with delays and cost overruns.

5. Conclusion

In 2013, Mexican politicians passed a comprehensive energy reform that was once thought to be political suicide (Huizar 2015). It opened the oil sector to competition and, using bidding rounds, it adjusted the government take on oil production to firms' willingness to invest. An independent regulatory agency now oversees the sector with a mandate to maximize long-term production versus short-run exploitation. In a large administrative reform, the politically powerful workers' union of Pemex, which had been blamed for blocking efficiency measures, lost their five seats on the Pemex company board and accepted cuts in their generous pension plans. Congress also passed a fiscal reform that is projected to increase the general tax burden of the economy by 2.5% of the GDP, which will reduce the state's dependency on oil rents. In this process of changing the rules of the oil sector, new political coalitions were forged and the state's roles and responsibilities were reconfigured, including a reengagement in industrial policy through a local content mandate.

This chapter explained the energy constitutional reform as an endogenous process triggered by a changing resource base from low-cost, easy to extract reservoirs, to technically complex and lower rent per barrel resources. In short, the change of geological endowment transformed the incentives of politicians, parties and suppliers, who then bargained over new rules of distribution of the oil sector. Mexico is a case where rules of distribution change by opening the sector to private investments, reducing the government take of oil activities and promoting industrial and scientific linkages through a local content policy.

The observed outcome is in line with the theory developed in this dissertation and summarized in this chapter, where I argue that the development of high-cost, high-risk resources is incompatible with a model of short-term rent-maximization, at the same time that it can attract new distributive pressures in the form of local content mandates. I tested these theoretical expectations with a historical analysis of Mexico's oil industry through three distinct periods, using data from various sources: archival, field production, financial statements, and interviews. The first period analyzed was the pre-boom years, when declining production led the executive to free more resources to Pemex through a combination of tax reduction and price increase. Pemex used the additional resources to boost exploration efforts and invest in science and technology with the creation of the Mexican Institute of Petroleum (IMP). The discovery of the super-giant field of Cantarell, which could be developed in record time and had a very low production cost, marked the second historical period. Cantarell allowed the Mexican State to consolidate a rentier relationship with Pemex. The depletion of Cantarell and the failure to discover

similar resource endowments started to pressure the old equilibrium that sustained rules that favored an oil-based rent-seeking coalition (Díaz-Cayeros 2013, Levy and Walton 2009), leading to a reformist period that started in 2008.

The situation faced by Pemex during the last decade bears a historical similarity to the early 1970s, when Mexico was importing crude oil to satisfy its energy needs. Analyzing those critical years, Antonio Bermúdez, the former CEO of Pemex from 1946 to 1958, argued that Pemex had been close to a collapse. The collapse was avoided because of discoveries in the Southeast of Tabasco and Chiapas. Bermúdez, however, worried that if mistakes from the past were not corrected, such as underinvestment in exploration and poor management practices, the windfall would be wasted and Pemex would fall again into a new crisis “of much larger proportion” (Bermúdez 1976, p. 82).

The crisis of larger proportion became unavoidable when Enrique Peña Nieto took office and proved reserves would last for just ten years, with rising production costs. PRI politicians changed their position from an intransigent defense of Pemex’s monopoly and the benefits of the workers’ union to support the reform, which included an open market model (sharing oil wealth with private operators) and benefits to suppliers (local content). This reversal was critical for the approval of a reformist agenda that was initiated by the previous PAN administration, which only became more urgent with the passing of time. As one drafter of the energy reform said, “This reform is what we wanted to do in 2008 but did not have political support” (Interview Garcia Alcocer 2015). Accordingly, the PRI kept in key positions within the government many civil servants who worked in the previous administration, including commissioners at the regulatory agency (CNH).

The weaknesses of the Mexican oil industry by the mid-2000s are the result of the interaction of geological and political factors. First, given an easy geology to work with (low cost of production and low exploration risk), Pemex did not face the same technological challenges and cost pressure of other state oil companies, like Petrobras and Petronas, so could indeed purchase services abroad to boost production from its plentiful conventional fields. In addition, the easy geology generated enough rents to channel it to the workers’ union, which further increased the operational costs of the company. The combination of these factors limited Pemex’s capabilities when, to compensate for the decline of its mature fields, it had to develop deepwater and tight oil resources, assets that require more in-house expertise, customized technological solutions, and a leaner cost structure. Second, given its short-term horizon, which was driven in part by Mexico’s six-year executive political election cycle, without reelection, Pemex was not given the resources that it needed to invest. Instead, it increased short-term

production and did not spend on technology development or the exploration of new reserves This is explained by the fact that investments in exploration in geologically risk areas and in R&D are uncertain and require larger time span to generate returns. The misalignment of incentives persisted as long as easy-oil was available, but the resource base change pressured for rules that allow for long-term planning and lower rent-taking. Besides, Pemex's monopoly condition limited the capacity of the company to leverage capital and knowledge with other operators in partnerships in upstream projects.

Finally, in the process of crafting the reform, the executive had to accommodate new distributive pressures that arose from the business sector interested in guaranteeing a share of the future oil contracts through a minimum local content target. As Pemex started to invest more in capital goods (in order to explore and develop high-cost oil resources), the economic impact of its activities on industrial demand became more salient, and starting with the 2008 energy reform the issue of local content became politically relevant. In the latest energy reform, it was seen as a way to directly secure part of the oil wealth to the domestic industrial sector. Following a legislative mandate and driven by a need to reduce the potential cost overrun from local content acquisitions that could hamper future oil production growth, the Mexican state reengaged in industrial policy in order to develop a local supply chain that can serve Pemex and new oil companies operating in the country.

Not all oil rich countries have the same geological conditions of Mexico, which includes a past abundance of a low-cost, super-giant oil field plus resources in deep offshore and shale. However, many could face similar situations as conventional fields deplete, rents per barrel decrease, and becomes necessary to employ technology-intensive methods of enhanced oil recovery to produce from mature-fields. The Mexican experience is likely to reflect broader societal trends in oil-rich countries and the challenges of energy reforms that have distributive implications and require realignments of political coalitions.

ANNEX

Cartera de inversiones en 2006

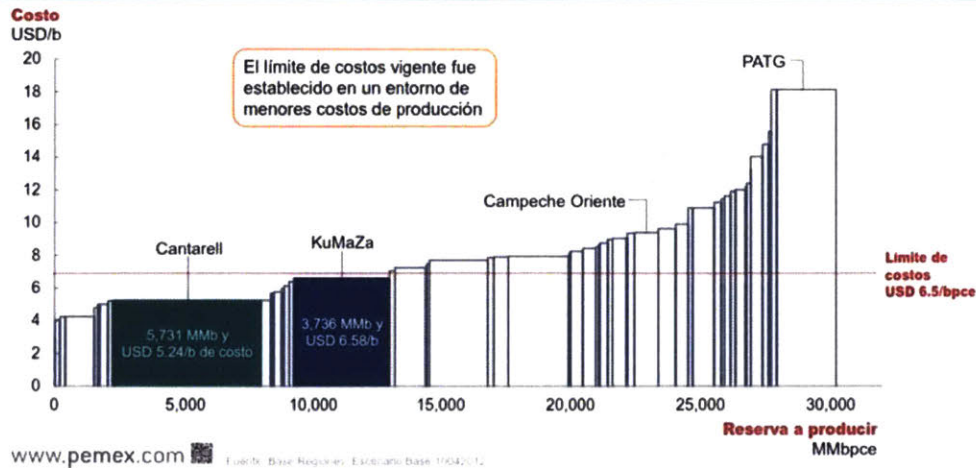


Figure 3.11: Cost of production of fields in operation in 2006

Cartera de inversiones en 2014

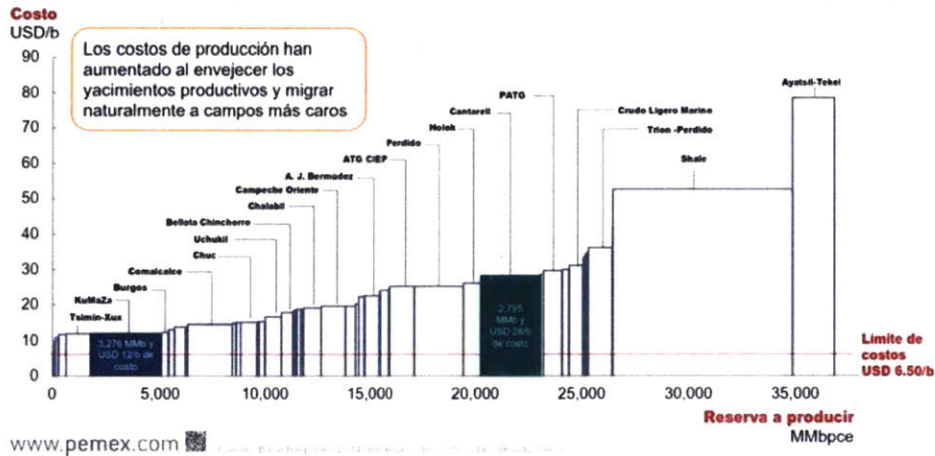


Figure 3.12: Cost of developing new reserves, per asset

Source for figures 3.11 and 3.12: Pemex. "Aspectos relevantes del nuevo régimen fiscal, presupuestario y de deuda de Petróleos Mexicanos," presentation made by Pemex's CFO Mario Beauregard to the Energy Commission, Chamber of Deputies, 03/24/2014. Available at:

<http://www3.diputados.gob.mx/camara/content/download/325933/1147666/file/PEMEX-20140624.pdf>

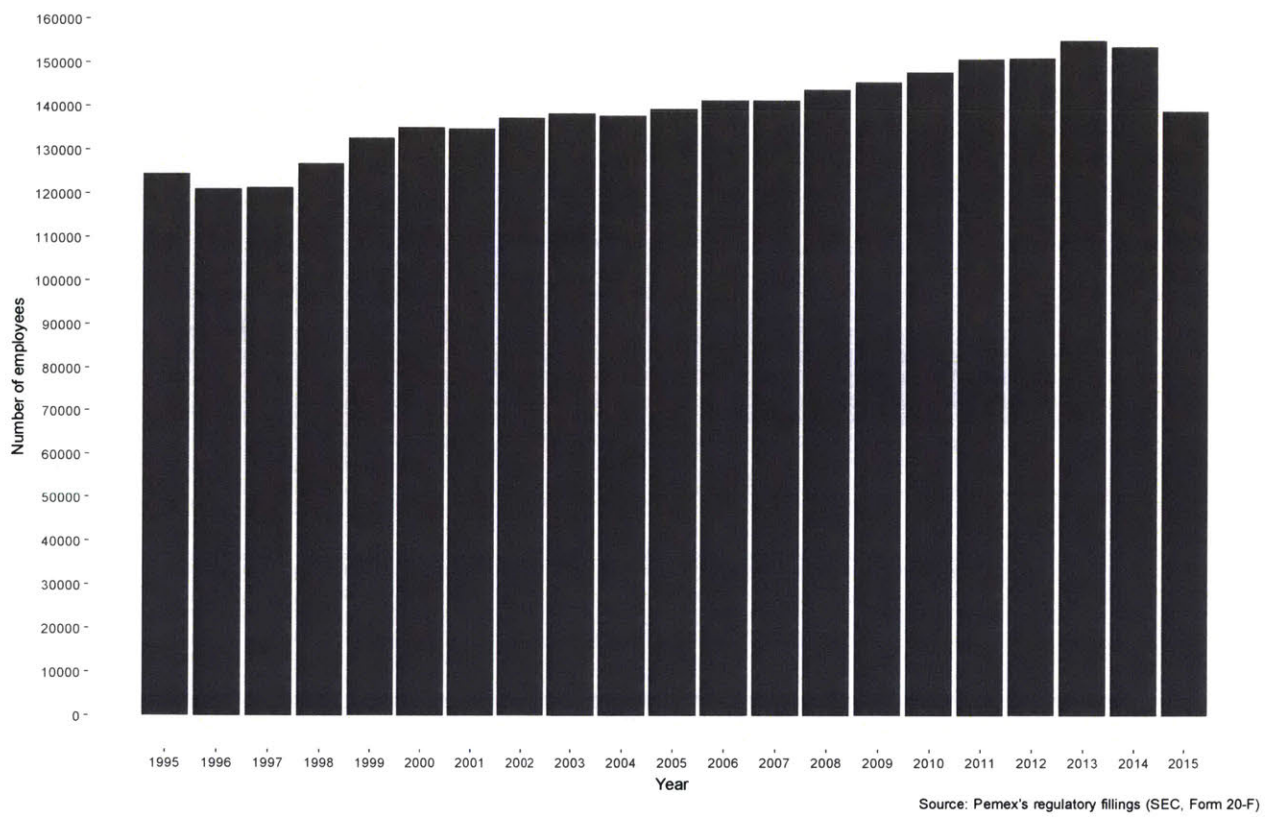


Figure 3.13: Total employment at Pemex (1995-2015)

Table 3.4: Pemex, selected financial indicators

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total sales	\$55,663	\$68,673	\$86,163	\$97,647	\$104,548	\$98,162	\$80,643	\$103,751	\$111,393	\$126,587	\$122,984	\$107,809	\$67,786
Cost of sales	\$22,950	\$28,264	\$39,887	\$37,047	\$42,394	\$48,310	\$41,518	\$51,168	\$55,797	\$63,988	\$62,250	\$58,791	\$74,439
Income before taxes and duties	\$30,241	\$40,774	\$46,959	\$57,725	\$60,642	\$48,723	\$33,441	\$49,096	\$56,076	\$69,580	\$53,136	\$32,649	-\$22,147
Tax and duties	\$34,037	\$42,108	\$53,873	\$53,566	\$62,327	\$57,001	\$40,445	\$52,936	\$62,615	\$69,380	\$66,141	\$50,691	\$19,266
Comprehensive income	-\$3,617	-\$2,263	-\$7,078	\$4,159	-\$1,685	-\$8,278	-\$7,004	-\$3,841	-\$6,539	-\$28,766	\$6,440	-\$36,071	-\$36,263

Source: Pemex's Consolidated Income Statement (2003-2015). Includes main sources of revenues and expenditures

Table 3.5: Summary of changes by the energy reforms

	Area	Before 2008	With the 2008 Energy Reform	With the 2013-2014 Energy Reform
Governance and regulations	Policy formulation and oversight	Centralized in Pemex with weak participation by the Ministry of Energy	Mostly Pemex, but increased oversight and planning by the Ministry of Energy and CNH	Ministry of Energy and CNH for O&G planning and production; ASEA for safety standards
	Independent regulatory agency?	No	No, CNH created as a unit linked and reporting to the Ministry of Energy	Yes, the law provides for CNH technical and operational independency, including a direct source of funding
	Selection of regulators	N/A	By the executive with a 5-year mandate, with possibility of one renewal	By a 2/3 majority vote of the Senate from a list of three candidates prepared by the executive. Regulators serve for a 7-year mandate with the possibility of one renewal
Pemex	Administrative structure of Pemex	Government autarky	Government autarky	State Productive Enterprise
	Board composition	11 members, 6 from the executive and 5 from the union	15 members, 6 from the executive, 5 from the union, and 4 approved by the Senate (from party members)	10 members, 5 appointed by the executive and 5 professional independent (without party affiliation) approved by 2/3 vote by the Senate
Contractual terms	Contractual forms available	Direct assignment to Pemex of areas for exploration and production	Direct assignment to Pemex and service contracts between Pemex and private oil companies	Direct assignment to Pemex, service contracts, production-sharing, profit-sharing and license
	Government take	Determined by the government, with a cost-deduction cap of \$6.50	Determined by the government, with increased deduction-cap for selected areas	Determined by competitive auction of areas, with royalties and duties charged on all producing fields
	Local content mandate	N/A	Pemex was asked to assess its total domestic purchases and increase them by 25%. No penalty or monitoring attached	A target of 35% by 2025, with verification by the Ministry of Economy. Lower targets for deep offshore, to be revised in 2025
	Revenue flows	To the executive and directly appropriated by the public budget	To the executive and directly appropriated by the public budget	To a fund managed by the Central Bank with a limit on budget appropriation
	R&D fund	N/A	0.65% of total sales	0.65% of total sales

Chapter 4:

When rents are secondary: Brazil's industrial and innovation policies in O&G

1. Introduction

In November of 2007, the Brazilian National Oil Company (NOC) Petrobras announced the discovery of a new oil province situated beneath a thick layer of salt in ultra-deep waters off the Southeast coast of Brazil. Present in this first field alone were anywhere from 5 to 8 billion barrels of oil in a pre-salt formation – as it came to be known.⁶⁵ It was there in hard-to-extract fields below 2,000 meters of water, unlocked by nationally developed technologies spearheaded by Petrobras and locally manufactured platforms, that Brazil would find its “passport to the future,” or so then-president Luiz Inácio Lula da Silva claimed.⁶⁶

The nationalistic discourse used by government officials following the announcement of Brazil's new vast oil resources had the typical exaggerated overtones of resource nationalism, but was partially grounded in reality. On the exaggerated side, Petrobras' discovery was made in partnership with international oil companies (IOCs) and using global suppliers as oilfield service providers – making the discovery hardly a product of autarky. At the same time, it was the product of years of investment in domestic research and development (R&D) and in a local supply chain. Policymakers would use the discovery to double down on the strategy of using the oil sector as an anchor of industrial and innovation policies, trying to internalize to the maximum extent possible the nearly one trillion dollars of capital investments necessary to develop the new resources (Leahy 2011).

The history of the oil industry in Brazil provides a stark contrast with enclave models of resource development, where little to no spillover impacts the economy, with the exception of fiscal rents that flow to public budgets. Born as a NOC in 1953 in an oil-poor country, Petrobras had the mission to find and develop O&G in Brazil, supporting the country's economic development and national (military) security. It also played a key role in Brazil's developmental state ambition of replacing imports – both of capital and of crude oil. To accomplish its mission, Petrobras has kept high levels of investment in R&D,

⁶⁵ At the time, Brazil's proved reserves were of 12 billion barrels of oil. Initial estimates of the pre-salt area were of 50 billion barrels of oil spread in a large area in the sedimentary basins of Espírito Santo, Campos and Santos (Rappel 2011).

⁶⁶ Lula da Silva (2009).

in nurturing local suppliers and in acquiring managerial capabilities in order to find and extract oil from Brazil's technically complex offshore resources.

Despite noticeable gains in producing oil from deeper fields, displaying technological and managerial prowess, by the mid-1990s Brazil's oil sector was still straightjacketed by a regulatory model that granted a monopoly to Petrobras. Production was about half of total consumption and growth was constrained by the capacity of the company to invest in exploration and production (E&P) activities that had high geological risk and costs. In addition, discoveries in deep offshore take up to ten years to generate cash flow that could help finance new investments from retained earnings. The then-prevailing regulatory framework was ill equipped to foster the development of Brazil's geology of costly and risky deep offshore resources.

Politicians in a center-right ruling coalition, led by the Brazilian Social Democratic Party (1995-2002), then, changed the O&G regulatory framework in 1997, moving from monopoly to a competitive environment monitored by an independent regulatory agency. To appease interest groups that feared that international oil companies (IOCs) would not be bound by the same mission to develop local suppliers and R&D labs as Petrobras had in the past, regulators put in place rules that would benefit local content purchases in bidding rounds and established a levy of 1% of gross production to be channeled to universities and laboratories. As investments in the sector increased so did the lobby of business associations interested in imposing higher targets of local content (hereafter, LC) on oil operators. Politicians also saw in the promotion of a local supply chain an opportunity to foster job creation and hold political rallies. Particularly during the center-left coalition led by the Worker's Party (2003-2016), labor-intensive industries like shipbuilding sprawled across Brazil's vast coastline to produce the variety of equipment used in the offshore industry, from the simpler platform supply vessels (PSVs) to billion-dollar drilling rigs, generating jobs for the party's constituency.

Given the rules in place, when the pre-salt was discovered, specialists saw its major impact in the economy coming from the multiplier effect of investment in goods, services, and human capital required to put the fields into production (Rappel 2011, p.54). This was echoed by then-president Dilma Rousseff, who in a visit to a shipyard in the state of Pernambuco – where no oil is produced but the platform P-62 had been constructed – celebrated the LC rules as necessary to guarantee national employment. And more job opportunities would come, according to her: “With the exploitation of pre-salt oil gaining speed and scale, Brazil will necessarily become the largest producer of oil platforms of the 21st century. We have to think big, the size of Brazil” (Rousseff 2013).

Brazil provides a clear contrast case with the view of the oil industry as a pure generator of rents – as was Mexico throughout most of the 20th century and particularly following the development of its super-giant, low-cost field, Cantarell. Brazil’s complex and costly geology created incentives for policymakers and suppliers to support the investment in R&D by the country’s NOC and partners and in the active participation of the local industry in the production chain through strong LC rules. A bargaining process with suppliers, oil companies, parties and the government shaped the evolution of the LC requirements and their stringency. Oil politics in Brazil is, above all else, the politics of its supply-chain, or contract-seeking, as I term it in Chapter 2. In this sense, it approximates the oil politics of Malaysia, but without the ethnic distributive pressures observed in that country. However, far from being a linearly good story of oil and development, in Brazil we observe heterogeneity: The politics of contracting built capabilities in Brazilian companies and attracted global suppliers to Brazil but has also been associated with overinvestments to please contractors and politicians and a large corruption scandal. The growth of oil production and reserves eased historical constraints on political interference in Brazil’s oil company and facilitated its capture by parties and a cartel of contractors, a point that deserves an analysis in its own, which will be done in the next chapter.

This chapter will address the industrial and innovation policies that Brazil adopted to develop its O&G sector. It is organized as follows. In Section 2, I provide a summary of the theory of innovation in the natural resource-sector, developed in Chapter 2, and use it to analyze how Brazil’s rules of distribution of oil wealth changed over time in response to geological and market conditions. Section 3 discusses how Petrobras worked over the years to innovate in deep offshore oil production in response to Brazil’s complex geology. Section 4 lays out the industrial policy mechanisms that had been negotiated in order to expand domestic capabilities and, in this way, maximize LC. Finally, Section 5 concludes.

2. From oil-poor to the “Saudi Arabia” of deep offshore: Brazil’s key changes in the rules of distribution of oil wealth

2.1. The explanatory framework

This section summarizes how the theory of geological constraints, innovation and rules of distribution of the natural resource-sector, developed in Chapter 2, applies to the Brazilian oil industry. It shows that Brazil’s executive government, which controlled Petrobras, the country’s National Oil Company (NOC), had a strong incentive to invest in developing capabilities to overcome the country’s

geological challenges. When capital availability for deep offshore projects became a major constraint to expand domestic production, a reformist political coalition changed the rules of the sector in the mid-1990s to allow private investments and oversight by an independent regulatory agency. The new rules also guaranteed a steady source of R&D funding through earmarking oil rents to domestically located labs and universities, further contributing to the development of the sector. Brazilian business associations and suppliers also shaped the evolution of the policies by pressuring policymakers to increase LC targets, seeking to secure a growing share of the high value contracts required to develop deep offshore oil wells. In order to make these growing targets feasible, the executive adopted industrial policy instruments that promoted the coordination of public-private investments. Furthermore, by extending local manufacturing capabilities, politicians could also reap the benefits of promoting labor-intensive industries.

As addressed in Chapter 2, oil production is influenced by below- and above-ground factors, and below-ground challenges will be more demanding of above-ground solutions to facilitate extraction. While conventional oil producers can more easily extract resources even with weak institutional regimes, high government take and limited investments in human resources and technological solutions, a challenging resource base will increase the returns for investing in rules and institutional complementarities that can support its development. This includes adjusting the government take to the (higher) business risks, allowing the sharing of geological risk and project costs between different companies, and promoting an innovation ecosystem that facilitates investment in public goods such as human capital and R&D.

It is worth noting again that investment decisions on exploratory programs involve a cost-benefit analysis that has the following probabilistic approach (Bhattacharyya 2011):

$$EMV = P \times NPV - E \quad (1)$$

where *EMV* is the expected monetary value, *P* is the probability of a successful discovery or the expected ratio of non-dry wells to the total number of wells drilled, *NPV* is the net present value of developing the field, and *E* is the exploration costs. Consequently, investment in exploration are less attractive under conditions of small reserves and high taxation, geological risk and exploration costs. On the other hand, high oil prices, sizable discoveries and favorable tax regimes can positively affect the *NPV*, hence the exploration activity. Finally, a high exploration and development cost (high-cost oil) creates contract-seeking incentives, where suppliers, workers and their representatives in the political

system will try to appropriate the wealth from high-cost barrel production by influencing rules of procurement (LC policies).

This perspective that starts from geological endowments and how they shape the incentives of the parts that bargain the rules of who can extract O&G, at what tax level and under which procurement requirements, serves as a guide to explain Brazil's rules of distribution over the years, including the move from state monopoly to competition, then to a partial monopoly for the pre-salt area. They also explain why, in Brazil, the oil industry developed strong linkages with universities and local suppliers and kept a low government take, one which enticed companies to explore and extract from the country's deep offshore resources.

2.2. Evolution of the rules of access to resources and government take

From the creation of Petrobras in 1953 up until 1995, the NOC had the monopoly of upstream operations in Brazil.⁶⁷ Petrobras and its owner, the federal government, invested in human capital development and R&D to master Brazil's geology and in developing local suppliers who could domestically support Petrobras' investment needs. This long-term strategy of capability building proved to be successful in increasing domestic production and reaching fields located in deeper water depths. However, by the mid-1990s, the growth of the industry had a severe institutional limitation: the high-cost and high-risk exploratory programs in deep offshore could not be shared with partners. While Petrobras proved to be technically able to manage complex projects and produce from deep-water reservoirs, it could only do so with its own investment capacity, which resulted in a pace below the needs of the country. The result was that, by the mid-1990s, Brazil was still importing about 60% of its oil needs.

A reformist government, headed by President Fernando Henrique Cardoso (1995-2002), proposed in 1995 a constitutional amendment (n° 9/1995) to end the monopoly of Petrobras. The bill

⁶⁷ In 1975, Ernesto Geisel as military president of Brazil (1974-1979) unilaterally introduced oil risk-contracts in the country, allowing private companies to partner with Petrobras in pre-determined areas, with the NOC retaining the monopoly of operations. This semi-opening was limited in scope and results, and was also short lived: there was only one notable discovery, the gas field of Merluza with 75 million barrels of oil equivalent (boe), and the practice was abolished in 1985 by the Brazilian Congress (Freire 2013). While important to develop Brazil's costly geology, this limited opening failed because it neither provided enough incentives for private companies to invest nor was based on a coalition of domestic players that could gain from the opening and sustain the new arrangement, as was later the case of suppliers with LC.

gave the federal government the freedom to license exploratory areas to other companies besides its own NOC. Despite strong opposition from the left, Cardoso's center-right political coalition backed the executive vision that the monopoly limited the expansion of Petrobras.⁶⁸ In 1997, the Congress approved a new legal framework which created the National Petroleum Agency (ANP), a regulatory agency charged with overseeing the sector and conducting bidding rounds for exploratory areas. In terms of government take, producing areas were set to pay royalties of up to 10% and highly productive fields pay an additional windfall tax that varies from 10% to 40% - which is both a progressive fiscal regime and modest in terms of the total government take (see Van Meurs 2008). Brazil, in the mid-1990s, followed a model similar to Norway, which combines a strong state-owned company (Statoil, in the Norwegian case) competing with private players, with separation of policy and regulatory functions (Thurber et al. 2011). Importantly, the rules attempted to bind the behavior of oil operators in the new open market for O&G in Brazil. What Petrobras used to do by itself – invest in R&D in Brazil and in developing suppliers – was institutionalized in formal rules in the form of LC policies and earmarked R&D resources, obligations that private companies would also have to follow.

The model adopted after 1997 successfully attracted private investments and brought competitive pressures that increased the efficiency of Petrobras (Bridgman et al. 2011, Dantas and Bell 2011, Lucas 2013, Pires and Schechtman 2013). Nonetheless, the regulatory framework was partly a victim of its own success when, in 2007, the discovery of large pre-salt reserves was announced and the government decided to review the regulations for this specific area.

Under the justification that the new oil area had a very low exploratory risk, the executive in 2009 decided to replace the concession system with a production-sharing regime, a system more commonly adopted in oil-rich countries for its supposed benefits in capturing more oil rents (Grunstein 2010). The new rules increased royalties from 10% to 15%, and determined a minimum profit-sharing of 41.65% and a substantive signature bonus. The new regulatory model also granted Petrobras the monopoly of operation of pre-salt areas – but, significantly, only secured a minimum participation of 30%, meaning that up to 70% of the total investments would be covered by private investors. Given a belief that in the pre-salt area there was a near certain probability of finding oil (high P), policymakers increased the rent capture in the new rules while doubling down on the strategy of using the oil industry as an anchor for LC promotion, as costs of production were very high. Brazil, claimed president Lula da Silva, would soon be able to join the Organization of the Petroleum Exporting Countries (OPEC), if it

⁶⁸ See Wolthers and Bramatti (1995) and Zylberstajn and Agel (2013).

wanted to, and it would have its own “oil sheiks” (Lula da Silva 2008). Under his direction, Petrobras would buy oil platforms in Brazil even if they cost a \$100 million more than imported ones. In a speech delivered to celebrate the start of operations of a new shipyard (Lula da Silva 2008), the president recognized, “From the point of the view of the company (Petrobras) it is true: it would be cheaper to import.” But, he continued, taking into account the employment created, the income effect in the region and the purchase of raw materials in Brazil by the shipyards, the country would gain by manufacturing it locally.

The pre-salt regulatory regime, thus, was based on an unusual combination of factors. First, costs of production were among the highest in the world, up to \$65 per barrel, unlike conventional oil producers (see Chapter 2, Table 2.2). Second, in terms of technological requirements, the pre-salt reservoirs were also among the most challenging in the industry. Third, given the high volume of reserves, for the first time it gave Brazil the prospective of access to high oil rents. Not necessarily per barrel, but coming from the sheer volume of production multiplied by the prevailing oil prices at the time the legislation was drafted, which had been hovering above \$100. The governance of the pre-salt area combined the distributive pressures coming from the supply chain (high LC), earmarked resources for R&D to support the development of a complex geology, and high government take. Such combination was dismantled when lower oil prices turned the regulatory arrangement prohibitive to the development of the sector. In a lower oil price scenario, the Brazilian Institute of Petroleum (IBP), an association of oil operators, pressured policymakers for lower LC targets to bring down the production price per barrel.⁶⁹ In addition, Petrobras’ monopoly of operations and a minimum 30% stake in all pre-salt fields became a hindrance to further develop the fields – and was eventually removed by a bill which the Congress approved in 2016, supported by the IBP and the executive.⁷⁰ These changes relaxed the conditions of access to resources (by ending Petrobras’ monopoly of operation) and cost of production (by adopting a lower and more flexible LC), thus helping to create future rents by increasing investments in exploration and production. The changes highlight how price pressures are more likely to influence the rules that govern the oil industry in high-cost producers, given their lower margins per barrel.

⁶⁹ Since 2015, after the fall of oil prices, the government signaled a relaxation of the rigidity of the LC policy, as in the Federal Decree 8637/2016, which created a program to stimulate the competitiveness of the O&G supply chain. These measures were still under analysis and implementation at the time of writing and only limited references will be made here.

⁷⁰ Law number 13365/2016, based on a proposal made in 2015 by senator José Serra (PSDB-SP).

Summarizing, Brazil's geology and political incentives of the main stakeholders of the natural resource sector were in line to adopt innovation and industrial policies in the oil sector – both in the period of oil scarcity as well as abundance of high-cost oil. However, when confronted with large reserve discoveries, it partly mirrored the behavior of other oil rich countries with respect to rent-capture and lack of financial discipline in its NOC, a point which will be addressed in Chapter 5. Such behavior was short lived, though, as lower oil prices provided a reality check to policymakers. The next sections analyze how incentives were translated to policies over the years, and the evolution of the instruments used to promote R&D and LC development.

3. Petrobras: Innovating to create rents from a challenging geology

Unlike traditional resource-rich Latin American countries like Venezuela, Ecuador and Mexico, Brazil was not blessed with an easy geology for hydrocarbon extraction. After an intense political campaign to nationalize the industry and develop the national O&G resources, the Getúlio Vargas' government created Petrobras in 1953 as an unusual NOC which had a monopoly of oil fields that were yet to be found – a first in the world in that situation (Smith 1976). Born out of scarcity, Petrobras had the mission to find and develop oil resources to meet domestic needs.

Oil production in Brazil started in onshore basins in the Northeast of the country but it soon became clear that these resources had limited potential. After years of mostly failed exploratory campaigns onshore, Petrobras made the strategic (and costly) decision to invest in offshore exploration. The first offshore discovery was made in 1968, in Sergipe, a small field named Guaricema, at 28m of water depth (Morais 2013). In purely economic terms, there was no reason to develop the field: a barrel in the international market was over three times cheaper than the cost of extracting it from Guaricema. However, the company decided to develop it thanks to long-term considerations of learning how to produce from offshore locations and military concerns that placed high value in energy security for developmental and defense purposes (Philip 1982). To achieve the objective of maximizing Brazil's oil potential, the military, which ruled Brazil from 1964 to 1985, also protected Petrobras from patronage practices that were common in other state companies and even Petrobras itself during João Goulart's administration from 1961 to 1964 (Geddes 1994, Oliveira 2012).

The strategic turn to offshore exploration paid off when significant resources were found in the mid-1970s in the Campos basin, off the state of Rio de Janeiro. First was the field of Garoupa (in 1974),

followed by a stream of discoveries of nearby fields (Dias and Quagliano 1993). After drillings confirmed the oil potential of the new discoveries, Petrobras had to prepare the long-term production structure and studied different offshore systems to put these fields into production, acting first as a “smart buyer” of technological solutions.⁷¹ For instance, after surveying different possibilities of platforms being used in the world, it settled for a floating, production, storage, and offloading (FPSO) facility to develop its Garoupa field – the second company in the world to adopt this type of solution, after Shell (Priest 2016). Also in the 1970s Petrobras created a subsidiary (Braspetro) to engage in international oil exploration.⁷²

With new discoveries in the coast of Brazil and the need to go further offshore in the country, and even venturing in international exploration, Petrobras strengthened its project management capabilities and became an active developer of technological solutions – in partnership with suppliers and research centers, both from Brazil and abroad. Its R&D center, Cenpes, founded in 1966, began as a unit that did mainly technical assistance and technological transfer, but gradually evolved to equipment engineering and indigenous research with a well-funded budget (Randall 1993). In 1986, Cenpes launched a technological capability program for deepwater with a clear target: be able to extract oil at depths up to 1000m (Procap 1000). To achieve this goal, researchers had to master subsea solutions that were at the international frontier of the industry at that time. The initiative was followed by a second similar program in 1992, with the goal of achieving capabilities to produce from water depths of up to 2000m (Procap 2000), and a third one, in 2000, to produce from 3000m (Procap 3000). In 2007, Petrobras crated a specific program to develop solutions to produce oil from pre-salt formations (Prosal) and deal with challenges such as corrossions arising from developing fields with high carbon dioxide (CO₂) and hydrogen sulfide (H₂S) content. To Morais (2013), while the bulk of the Procap 1000 projects could be characterized as incremental innovation, later editions were significantly devoted to radical innovation.

⁷¹ In the process of evaluating new offshore production technologies in the 1970s, Petrobras sought the assistance of the Post-Graduation and Research in Engineering program of the Federal University of Rio de Janeiro (Coppe/UFRJ), developing a close relationship over the years. Coppe also helped Petrobras to develop new suppliers by providing them with technical support, testing and certification (Interview Estefen 2016).

⁷² Braspetro operated in a wide number of countries, such as Angola, Colombia, Guatemala, Egypt, India, Iraq, and Iran (Dias and Quagliano 1993). In 1976, the Brazilian team of oil explorers discovered one of the largest fields in the world, Majnoon, in Iraq, with at least 25 billion barrels of oil. The field was then nationalized by the Iraq government and Petrobras took only a marginal role in its subsequent development – which had also been affected by wars and sanctions. Majnoon is currently under operation, through a service contract, by a consortium of Shell, Petronas and Iraq’s NOC (INOC) (Freire 2013).

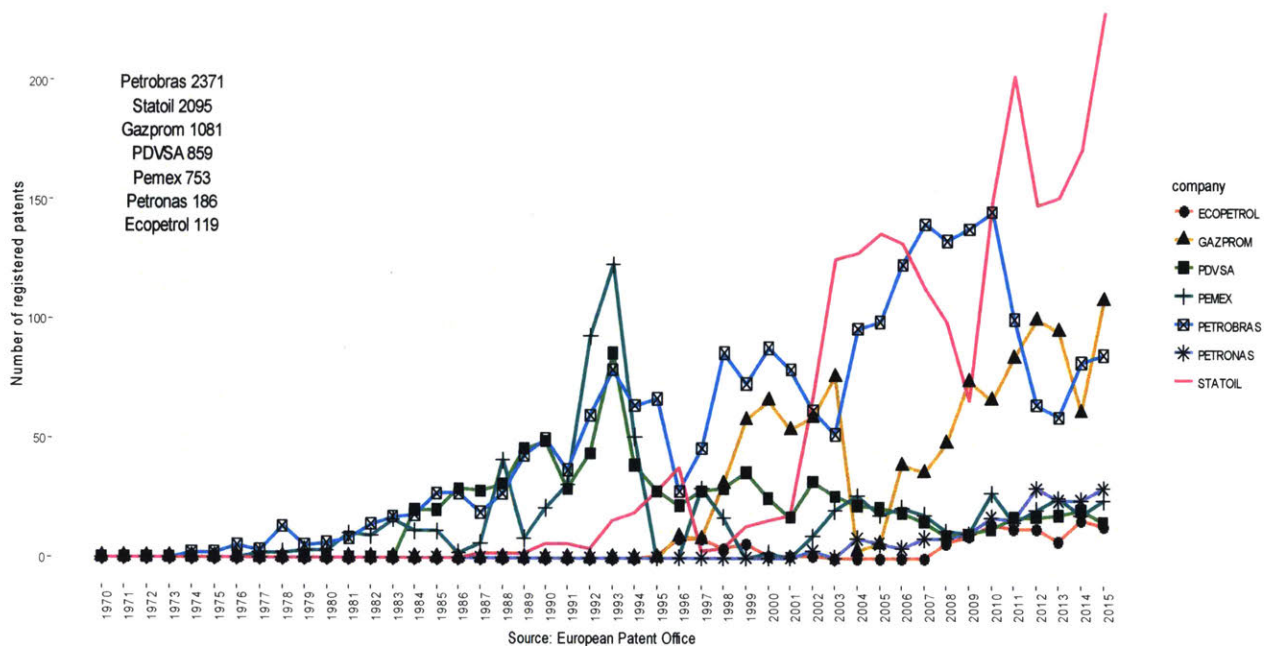


Figure 4.1: Patents registered by selected NOCs (1970-2015)

Thanks to Procap and the knowledge networks that Petrobras built with suppliers and research centers, the company progressively went further offshore, registering some of the world records for deep water oil operations. The achievements were recognized by the world industry and Petrobras received three times the Offshore Technology Conference (OTC) Distinguished Achievement Award (1992, 2001, 2015), a prize that has existed since 1971 – Statoil is the only other NOC to have received the distinction.⁷³ To Priest (2016), the proper comparison to Petrobras is not other NOCs created to manage national resources that were known to exist in abundance, like PDVSA, Pemex, and even Statoil, but rather Shell Oil, an offshore oil pioneer. In fact, comparing patent data of NOCs (Figure 4.1) – a crude but widely used indicator of innovation activities – reveals that Petrobras has more patents registered (2371) than other NOCs which enjoyed higher levels of oil production. In second place comes the Norwegian Statoil (2095) – a company that also had to operate under the challenging conditions of offshore oil production. Through Braspetro – later incorporated as Petrobras international – the

⁷³ The award has been given to universities, suppliers, and oil operators. Shell currently leads the number of awards with five recognitions (1971, 1982, 1998, 2004, 2012). See OTC (2016).

company used their domestically grown deep offshore expertise to develop areas in the North Sea (Norway and the UK), the US Gulf of Mexico, Angola, Nigeria, among others (Freire 2013).

The trend in Brazil has been to go deeper and deeper in terms of oil production. In 2015, 82% of Brazil’s oil production originated from deep offshore fields, while only 6% of the world’s oil came from this source a few years before (IEA 2012). Taking into account oil production by field and averaging it by water depth, in 1995 a barrel in Brazil was produced from wells located at 464m, while in 2015 it was of 1257m (Figure 4.2). Such growth was supported by institutional changes that opened the Brazilian market for competition, allowing Petrobras to partner with private investors in the costly deep offshore projects, and earmarked oil rents to R&D and human capital development in Brazil.

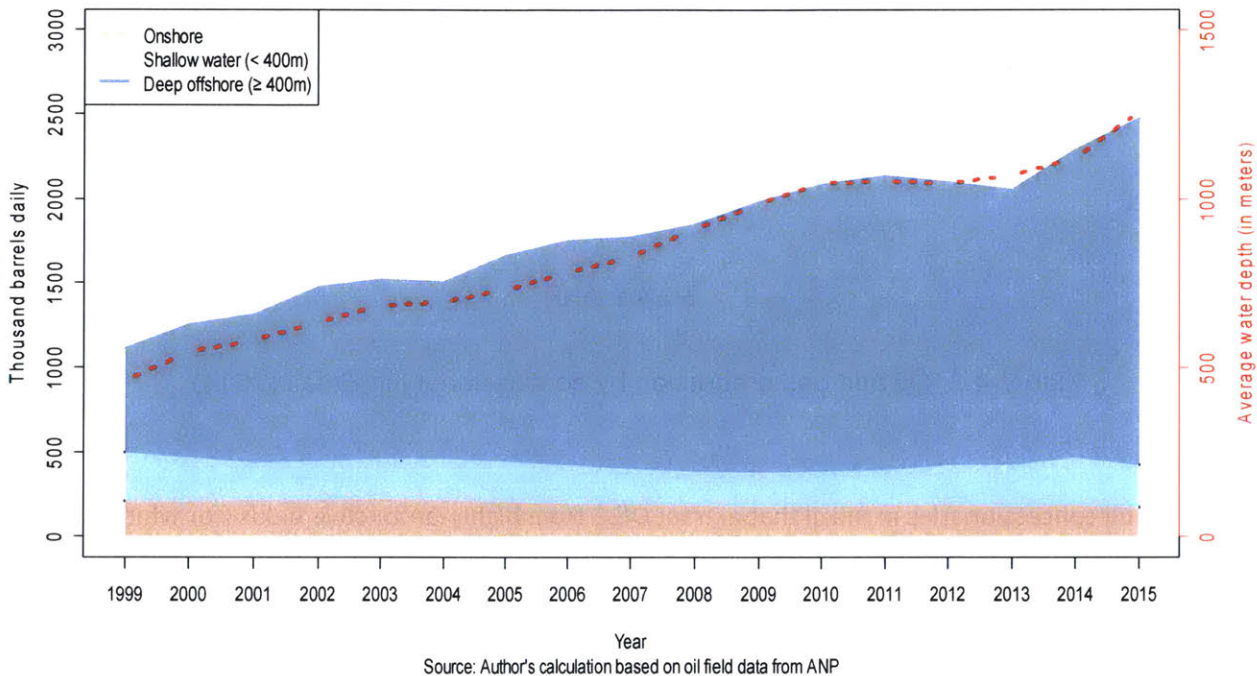
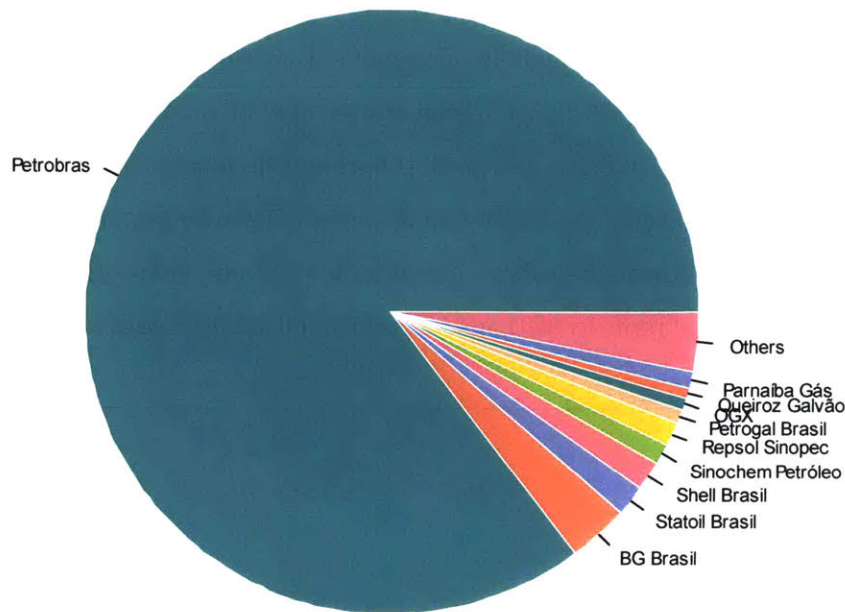


Figure 4.2: Brazil’s oil production and average water depth

Since 1999, ANP has been conducting bidding rounds offering areas for exploration, open to any qualified company. However, Petrobras kept a *de facto* monopoly of oil production given its technical capabilities and deep knowledge of Brazil’s geology. While majors like Shell, Statoil, and Chevron extract O&G in Brazil with their own platforms, their market share is small. Nevertheless, in many fields, including in the pre-salt, Petrobras works in partnership with other companies, which had been critical to raise capital for deep offshore development, helping to consolidate Brazil’s leadership in this

segment. Taking into account the participation of partners in the oil production, the market share of Petrobras was 85% as of 2014 (Figure 4.3).



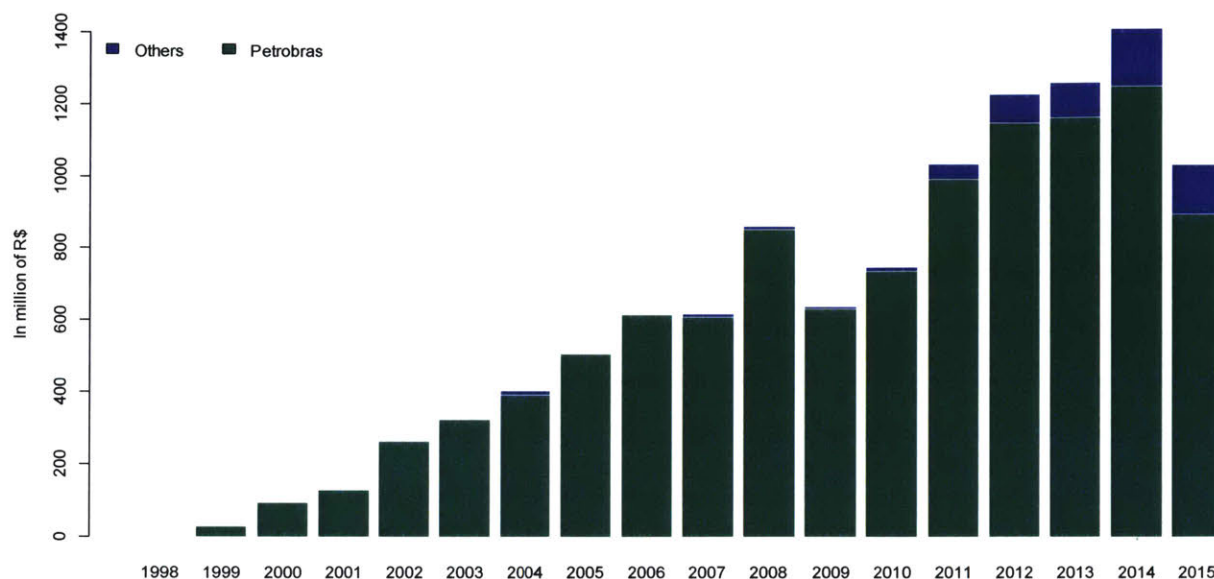
Source: ANP

Figure 4.3: Oil and gas production by concessionary in Brazil (2014)

All oil concessionaries in Brazil that extract O&G from highly-productive fields (for which is charged a windfall profit) have to commit to invest 1% of the gross value of the oil production into R&D projects in the areas of oil, natural gas and biofuels. Up to half of that amount can be invested in internal R&D centers (such as Cenpes, for Petrobras) or by private partners with R&D operations in Brazil (such as Schlumberger's lab in Brazil). The remainder has to go to nonprofit institutions, such as universities and research and technology organizations (RTOs), accredited by ANP. From this source alone, over R\$15 billion have been invested in R&D for the domestic energy industry from 1998 to 2015.⁷⁴ However, this source represents only the minimum legal requirement. From 2001 to 2014, Petrobras invested over \$10 billion in R&D (Petrobras 2015), or about R\$32 billion.

⁷⁴ Author's calculation based on data from ANP (2016). Past amounts were corrected for inflation. For comparison, this amount represents about half of the total cost of hosting the 2014 World Cup, including the building and reform of stadiums, metros, and airports (R\$ 27.1 billion).

Given Petrobras' market share, it also leads in terms of R&D allocation following this regulatory clause (Figure 4.4). However, the trend has been of an increasing share of resources coming from other oil companies, particularly Shell-BG (UK), Statoil (NO), Repsol-Sinopec (ES-CH) and Sinochem (CH), as production from their assets start to come online.



Source: ANP

Figure 4.4: R&D contractual clause expenditures (1998-2015)

In addition to R&D resources channeled to universities and RTOs, the growth of deep offshore oil production in Brazil and its technological challenges attracted in-house R&D centers of global suppliers, such as Schlumberger, GE O&G and FMC, particularly to an innovation cluster next to the campus of the Federal University of Rio de Janeiro (UFRJ). R&D facilities located in Brazil have developed globally relevant solutions. For instance, Cavalheiro et al. (2014) show that after the discovery of the pre-salt, there was a boom of patent filings in Brazil by global oilfield service companies.

An extensive analysis of the effect of the partnerships developed by Petrobras with research institutions in Brazil pointed out that the key role played by the NOC and ANP in the country's national innovation system (Turchi et al. 2013). A survey with the principal investigators (PIs) of Petrobras-funded projects showed that, by 2010, oil rents channeled to research institutions funded the creation of 165 new laboratories and reformed and expanded 282 others, developed 332 products, 253 processes and 531 new technologies. Projects done in partnership with Petrobras led to 3719 academic publications,

2479 master's theses, and 1738 doctoral dissertations (Porto et al. 2013). While the O&G industry represented a major source of funding for research organizations in Brazil at the same that it called for innovative solutions to support the growth of the sector, another set of public policies aimed at promoting domestic manufacturing emerged. There, policies were not tied to an innovation agenda, but rather to secure supply opportunities for companies located in Brazil, in particular the promotion of jobs in labor-intensive industries of the value chain.

4. Promoting local content

Between 1995 and 1999, from the constitutional change that opened the oil sector to the first bidding round that effectively ended the monopoly of Petrobras, the administration of the NOC prepared the company for a competitive environment, trying to mirror the behavior of what private companies would do. One of the measures triggered intense opposition from suppliers, work associations and politicians: Petrobras decided to purchase abroad 12 new oil platforms. The Federation of Industries of the State of Rio de Janeiro (Firjan) reacted creating, in 1998, a movement to increase the competitiveness of Brazilian companies of the O&G sector so they could again become suppliers of Petrobras (Fernández 2013). On its front, the oil regulator (ANP) commissioned a study of the conditions necessary to increase the participation of the national industry in the supply chain to guide future public policies. Equipment suppliers organized one specific business association (National Organization of the Oil Industry, ONIP in the Portuguese acronym) to defend the maximization of the national supply industry and to lobby for preferential policies. Other associations, such as the National Union of the Naval and Offshore Construction and Repair Industry (Sinaval) and the O&G division of the Brazilian Machinery Builders' Association (Abimaq) made their case to policymakers and politicians for the benefits of prioritizing the domestic industry in the regulatory framework of the oil market opening.

Brazil's formal LC rules, consequently, have to be understood in the context of the end of the state monopoly and the fears that private operators would sideline Brazilian firms in their procurement strategy (Guimarães 2012). Worse yet, Petrobras operating under a competitive environment could do the same. This turned out not to be the case as suppliers helped to shape future policies for their benefit (and in opposition to the interest of oil operators) and found a strong ally in the rise of the Worker's Party (PT), which came to power in 2003 with an agenda that included the pursuit of an active industrial policy (Kupfer et al. 2013). The LC policy changed from an incentive offered to operators to prioritize

local purchases to a requirement, allowing the supply chain to capture a growing share of the total investments made by the oil industry – which occurred at an unprecedented pace. Brazil’s Development Bank (BNDES) estimated that the O&G industry’s gross fixed capital formation increased from 3.5% of the GDP in 2000 to 10% in 2013 (BNDES 2014). A study of the impact of LC policies in Brazil made by the Federation of Industries of the State of São Paulo (Fiesp) estimates that the supply chain alone is responsible for 3.7% of the country’s GDP, employing directly about 700 thousand people (Coelho 2017). Despite the fall of oil prices beginning in 2014, the O&G industry remained the leading sector for new industrial investments as captured by BNDES’ surveys.⁷⁵ The impressive magnitude of recent investments is clearly shown in Figure 4.5, which provides a time-series of Petrobras’ capital investments (CAPEX), in real 2015 US dollars, from 1954 to 2015. From 2004 to 2015, Petrobras invested \$359 billion, more than four times what it did in the previous 50 years of its history, which sums to \$87.3 billion.

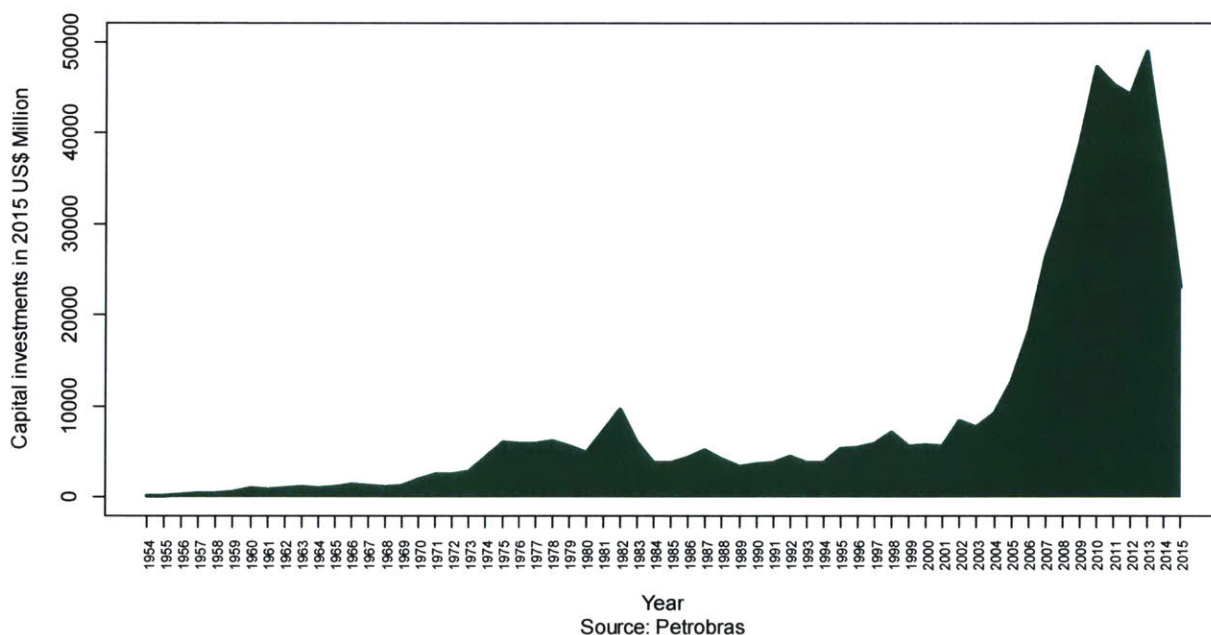


Figure 4.5: Total investments by Petrobras (1954-2015) in 2015 US\$

This volume of investments has been an opportunity for the supply chain but also a challenge to the Brazilian government and oil companies, particularly (but not only) Petrobras. To make the maximum participation of Brazilian companies in the O&G value chain feasible, governments of all levels

⁷⁵ Interviews with André Pompeu and Ricardo Costa (2016).

of the federation and the private sector negotiated industrial policy instruments. The goals of these instruments were to coordinate public-private investments, such as human resource training and infrastructure for new manufacturing sites, and to anchor expectations and bring predictability about future demand. The promotion of LC in Brazil involved institutionalized mechanisms in the bidding rounds, the coordination of public-private investments through the Program for the Mobilization of the National Oil & Natural Gas Industry (Prominp) program, and direct government procurement using Petrobras.

4.1. Local content clauses in the concession contracts

ANP conducted the first bidding round for exploratory areas in 1999. Already then, under the administration of Fernando Henrique Cardoso (PSDB) and by pressure of the group of firms that later came to form the ONIP, the oil regulatory agency (ANP) added an LC clause in the concession contracts and the auctioning rules (Quintans 2010, Zylbersztajn e Agel 2013). Oil companies were free to specify how much they would procure from domestically located suppliers and this would count as 15% of the offer – the remainder being the signature bonus and the minimum exploratory program. To president Cardoso, the opening of the oil sector was done alongside a policy to develop a local supply industry through incentives to investment, but careful enough to avoid excessive costs and delays (Cardoso 2013). However, over time, the definition of what constitutes a LC good and its weight in the bidding rounds changed – increasing in importance and becoming more rigid.⁷⁶ The definition started as any good sold by a Brazilian supplier (Round 1), became one which had at least 60% of local manufacturing (Rounds 2 to 6), and evolved, from Round 7 onwards, after consultations with industry participants, to a meticulous system that measures with precision the domestic value-added as a share of the total cost of the good, with certification by accredited companies (Magalhaes et al. 2011, Quintans 2010). Regarding its weight in the bidding rounds, it started as an optional variable in rounds 1 to 4 (1999 to 2002). In 2003, the National Petroleum Council, headed by the then-minister of Mines and Energy Dilma Rousseff, determined to the regulator, ANP, to make LC mandatory and “to constantly adjust it to the evolution of the production capacity of the national industry and its technological limits.” (MME 2003). Therefore, LC

⁷⁶ Only after the fall of oil prices in late 2014 the policy was revised introducing more flexibility and export incentives.

became mandatory with a minimum share starting in Round 5 in 2003, and in 2005 (Round 7) LC was put within a range of minimum and maximum share in the bid offers.

In addition to introducing a certification system to monitor how much LC existed in the whole supply chain, beginning in Round 7, the government made all oil companies to commit, in their concession contract, to follow a list of about 40 categories and sub-categories in their procurement, each with a specific minimum LC percentage. For instance, an oil operator had to commit, in contract, to use 45% of LC in their well head, 80% in the casing of a well, 30% of its well equipment, and so on. The categories, and sub-categories are described in a booklet published by ANP. Which components were included in the booklet and their specific percentage were obviously not random: they were a result of information-sharing between the stakeholders of the sector, particularly policymakers and suppliers. The changes in the LC weight in the bidding rounds were a result of learning by policymakers and pressure from suppliers interested in capturing a higher share of the growing investments of oil companies. On the learning side, for example, a maximum amount of LC was adopted after the government perceived that some companies were offering unrealistic LC promises, giving them unfair advantage in the bidding round (Interview Almeida 2014). The process of defining what the booklet included ended up being captured by associations of suppliers. In order to promote the demand of goods from their members, they insisted that the booklet be both rigid and broad – there are many items and every one of them has to be reached under penalty of incurring large fines. As recognized by the head of LC at ANP, “The booklet adopted from Round 7 onwards is the result of a battle in the sector, of industry lobby, where you see [requirements] from cathode protection to wet Christmas tree” (Interview Rodrigues 2015). In other words, from very simple to very complex types of goods.

Interviews with key stakeholders and even a report from the Federal Audit Court (TCU) all point out that the policy was shaped by the interactions between the Ministry of Energy, the formulator of policies, and suppliers and business associations (TCU 2016).⁷⁷ Targets were set according to the theoretical capacity claimed by local suppliers – without sunset clauses or reciprocity agreements, such as passing gains derived from learning-by-doing (TCU 2016, p. 12). It also became more inclusive over time. While it started with about 40 categories in 2005, by 2013, in the first bidding for a pre-salt area, the list of contractual obligations had grown to about 70 categories (see Annex 1).

⁷⁷ As put by the Secretary for Oil and Gas of the Ministry of Energy, “when we define a local content target for each equipment, we sit with the industry, we sit with Petrobras, and we see what is the capacity of the industry to fulfill it” (Interview Almeida 2014).

Suppliers, naturally, had an incentive to overestimate their capabilities in order to obtain higher minimum targets. In addition, there is an inherent uncertainty on a policy that commits operators to purchase a fixed share of local goods at the time of bidding. Because it may take years after the early exploration of an area for a discovery and its development, there is a potential mismatch between the LC promised in the bid and what suppliers can actually deliver, years later, if oil is actually found. For offshore projects, this typically ranges from five to seven years – making it much harder to commit today to develop a project that is barely profitable at current prices.⁷⁸ This uncertainty later became well known by oil companies and LC turned out to be a new business risk variable (Almeida and Martinez-Prieto 2014, interviews A. Guimarães 2012, Passos 2016). However, this effect was neglected at first by oil operators, which tended to make offers promising a maximum of LC in order to maximize their chances of winning exploratory acreage. The situation changed when the development of the portfolio of projects revealed the limitations of the local industry in terms of price and time to market. Moreover, ANP proved to be an effective regulator in monitoring the compliance of the LC clause and in enforcing contractual fines. Operators then changed their behavior in bidding rounds to offer just the minimum LC required (see Figure 4.6). They also became more vocal in their opposition to the rigid and costly rules through their association, the IBP, which represented the sector in demands in Congress, the executive and through publications with public policy suggestions (e.g. IBP 2015, Almeida et al. 2016).

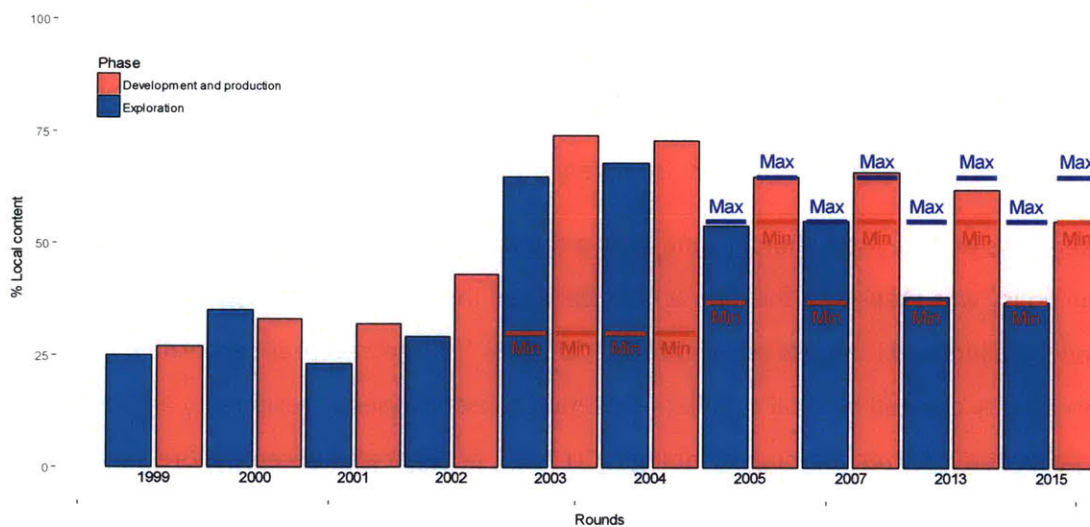


Figure 4.6: Average local content offers for ten O&G bidding rounds (deep offshore blocks)

⁷⁸ Oil majors are typically more conservative in engaging in projects that are profitable only with historically very high prices. The recent growth of unconventional resources – oil sands, shale gas and tight oil – was pioneered by smaller oil companies, which developed the more costly fields that were not under the commercial radar of the majors (Maugeri 2012, Zuckerman 2013) and faced severe financial strain once the oil price dropped below \$100.

A credible threat of punishment in case targets are not met is a critical component for the effectiveness of a policy that aims to stimulate oil companies to seek local suppliers in their procurement strategies, or actively invest in their development, where local capabilities are lacking. In the case of Brazil, ANP was put in charge of monitoring the LC compliance and establishing fines according to the share of unfulfilled LC. Audits are individualized per block and the results are public.⁷⁹ By accessing each report and extracting the identity of the operator, the type of the block (onshore or offshore), and the bidding round in which the block was purchased, I analyzed the evolution of LC enforcement in Brazil. By early 2016, 345 audit reports were available from various bidding rounds, of which 113 were for offshore and 232 were for onshore blocks.⁸⁰ Table 4.1 summarizes this data by round number:

Table 4.1: ANP's local content audit:

Bidding Round	Bid year	Total cases audited	Non-compliant cases	Percentage
1	1999	14	0	0.00%
2	2000	17	0	0.00%
3	2001	22	0	0.00%
4	2002	8	0	0.00%
5	2003	68	19	27.94%
6	2004	79	60	75.95%
7	2005	118	27	22.88%
AM 1	2005	12	0	0.00%
9	2007	6	1	16.67%

Source: Author's calculation based on ANP

Clearly, the higher LC requirements and certification rules from round 5 onwards led to an increase in the frequency of LC fines. The amount of each fine also increased in the period analyzed. Table 4.2 presents the results of a regression of the fines paid by oil operators (in logarithm). The independent variables are the round numbers, the location of the block (onshore or offshore), and type of oil operator.⁸¹ The baseline was set to offshore fields and Petrobras as operator. Results show that

⁷⁹ Data collection was finalized with the reports available by January of 2016.

⁸⁰ Round 8 was cancelled by the National Energy Policy Council after a judicial decision that suspended the bidding round. AM1 refers to a round exclusively for onshore, marginal fields.

⁸¹ In the dataset there are 28 small national operators (such as UTC Óleo e Gás S.A., Petroserv., PetroRecôncavo, QGEP) and 32 IOCs (including Statoil, BG, Esso, Eni, Repsol, etc.).

finer for Round 7 and 9 – Round 8 was cancelled – are significantly higher. However, small national operators tend to pay lower fines – which can be explained by their involvement in simpler projects with lower capital, technological, and delivery requirements. Summing up all fines paid by oil operators to ANP by the end of 2015, over R\$350 million was paid, and the mean fine value was R\$4.7 million.

Table 4.2: Determinants of LC fines

Variable	(I)
Intercept	11.78*** (0.68)
Onshore	0.04 (0.66)
Round 6	-0.23 (0.64)
Round 7	1.75* (0.86)
Round 9	1.59* (0.68)
Major_operator	-0.55 (0.60)
Small_national	-1.67* (0.78)

Robust standard errors in parentheses

DV: log of the fine charged to oil operators

Adjusted R-squared: 0.09

After committing to purchase a high share of domestic goods by participating in the bidding rounds, operators are left with four options. The first is to take the market as given: fulfill the target and purchase locally even if it means higher prices and longer delivery times. The second is to influence market conditions by developing local suppliers: transferring capabilities and pushing foreign suppliers to localize manufacturing plants in the country. The third is to ask the regulator for a waiver, a contractual instrument to be granted when the company is able to document the impossibility of fulfilling the LC requirement of a specific category due to excessive price difference or delivery time. Finally, oil companies can pay the fine for not reaching the contractual obligations and recognize it as the price of doing business in Brazil.

In order to select among these choices, oil operators evolved from having a procurement department to having one that manages LC. The latter involves more business strategy on identifying and developing local suppliers. This involves meetings with firms along the value chain to understand their constraints to increase the domestic value-added as well as working together to reach targets that can minimize fines to the operator. Vinicius Passos, LC manager of the Brazilian QGEP private operator (and former industrial policy manager at Total), provides an example: “Sometimes we have a supplier which has 30% of local content. We work with the firm to know how we can reach 50%. We challenge it. We ask if they need to change the machinery, or the chemical product used” (Interview Passos 2016). This shows, as argued in Chapter 2, that LC policies create incentives for oil companies to monitor suppliers and develop capabilities.

Given its strong capital demand, market power to influence suppliers, and exposure to fines in case of not fulfilling LC obligations, Petrobras was the company to invest the most in building LC development capabilities, as explained by the head of LC at Petrobras: “Given the magnitude of our investment portfolio, Petrobras understood that we needed an industrial park able to respond to its demand for goods and services,” says Paulo Alonso, stressing the obligations made during bidding rounds starting in the late 1990s (Interview Alonso 2012). To meet legal LC targets and even go beyond them, Petrobras employees, occupying policymaking positions in the Ministry of Energy, devised the Prominp industrial policy program in 2003.

4.2. Public-private coordination: Prominp

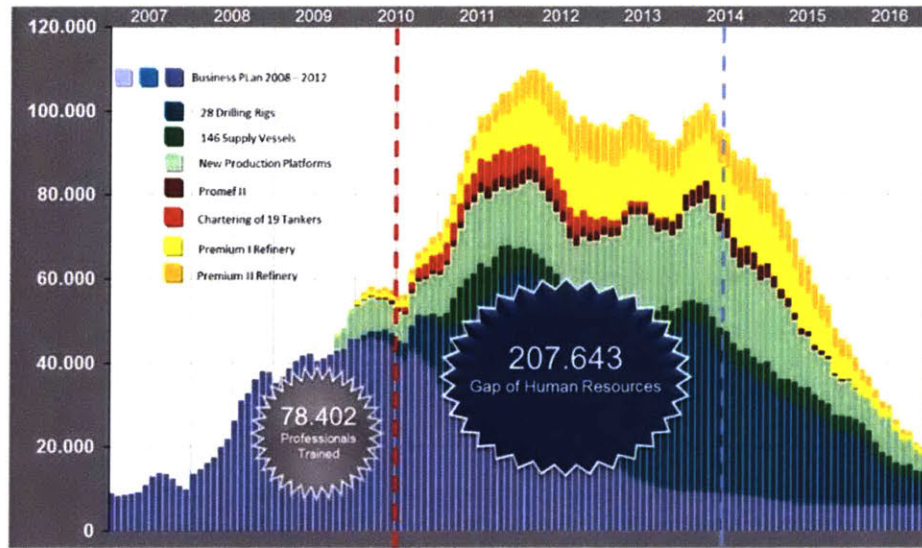
The growth of oil production in Brazil would already have a natural, market-driven impact in increasing the demand for the domestic supply sector. With strong LC requirements in place, an even higher demand has been created. In order to support the growth of the O&G industry and help to meet the LC targets, the government and Petrobras established Prominp. The program provides a coordinating function by fostering discussions among the main stakeholders of the O&G industry that identify bottlenecks and measures that could enhance the capacity and competitiveness of the industry based in Brazil. Through Prominp and other initiatives, Petrobras went above and beyond the use of LC to meet its regulatory obligation and started to heavily promote the expansion of the domestic supply base, often driven by political pressures, as the company itself has recognized (Petrobras 2013, p.18).

Prominp was formally created by a federal decree, in 2003, as a program to increase LC in the oil industry on a “competitive and sustainable” basis.⁸² Among recent industrial policies in Brazil, Prominp comes closest to the concept of embedded autonomy (Evans 1995) and provides a forum for business-government collaboration. The program facilitates the flow of information between the main stakeholders of the industry, a critical component in the design of effective industrial policies (Schneider 2015a). The program acts as a coordination forum where the government, Petrobras, and industry associations work together on projects and policy design. The forum is composed of representatives of federal and local governmental agencies in addition to business associations (CNI, ONIP, ABDIB, ABIMAQ, IBP, SINAVAL, and others). Through Prominp, the state has direct information from its agent (Petrobras) and also the supplier industries and service firms. The head of LC at Petrobras works as executive-secretary of the program, which operates in three areas: vocational training, development of industrial policy instruments, and monitoring of industrial performance.

The members of the forum regularly meet and exchange information, working on specific task forces. For example, Petrobras informs suppliers of its forthcoming demand for ships, bidding conditions, and financing options, while suppliers discuss their industrial capacity and bottlenecks to expanding production. Forum discussions are organized around a portfolio of projects – initiatives aimed at solving a specific issue. Each project is continuously monitored and may result in new public policies adopted by the Federal Government or a change of internal procedures by Petrobras. Through this portfolio of projects, Prominp tries to match the demand of the growing oil industry in Brazil with the capacity of local firms to supply industrial goods, services, and skilled workers.

Figure 4.7 provides an example of the work of Prominp regarding vocational training. Starting from an estimation of Petrobras’ future demand, the program creates a work plan to avoid a gap on human resource availability by sponsoring training programs. From 2006 up to 2015, Prominp granted scholarships to about 100 thousand workers of 185 professional categories (Prominp 2016). Training is done in partnership with 80 different institutions, including public universities, and agencies such as the National Service for Industrial Training (Senai).

⁸² Decree n. 4925/03, which was co-signed by president Lula da Silva and the then Minister of Energy, and Lula’s successor, Dilma Rousseff. At the time, Maria das Graças Foster (president of Petrobras between 2011 and 2015) was the Secretary of Oil, Natural Gas, and Renewable Fuels at the Ministry of Energy, and she was a key person in the implementation of Prominp.



Source: Adapted from Petrobras (2010)

Figure 4.7: Projected human resources demand and expected training needs

Through Prominp, both Petrobras and the Federal Government adopted new policies that resulted in changes of the tax regime for suppliers and easier financing conditions. The success of Prominp in developing domestic productive capability became critical to define the rhythm of access to exploratory areas. Brazil’s production sharing law – adopted exclusively for the pre-salt area – made it clear that the selection of areas for bid would have to consider the country’s energy policy and “the development and the capacity of the national industry for the supply of goods and services.” (Article 9, Section 1, Law 12.351/10). Given this legal requirement, the Secretary for Oil and Gas of the Ministry of Energy, Marco Antonio Almeida, was working with Prominp to assess the responsiveness of the domestic industrial park to different levels of projected demand. “The law imposes that. The offer of [exploratory] blocks will have to consider the capacity of the Brazilian industry,” stressed the policymaker (Interview Almeida 2014). Furthermore, he highlighted that it would be easy for the government to speed up oil production by auctioning new areas of the pre-salt already identified with high potential, but the model adopted was designed to match the development of the oil production with the domestic supply capacity.

While the pre-salt legal framework increased rent-capture, including raising royalties from 10% to 15%, lawmakers made provisions to keep the oil industry in Brazil as a generator of contracts rather than just rents. The capacity of the domestic supply chain was set in law as a key variable to determine

the pace of future exploitation. The government had also been directly involved in promoting new supply capacity, particularly in the labor-intensive segment of the naval industry.

4.3. Direct government purchase: Promef and Sete Brasil

Deep offshore oil production is not only technically challenging – it is an activity that mobilizes a number of equipment and services. The development of a single medium-sized offshore field costs approximately \$1 billion (Jahn et al. 2008). Deep offshore wells are particularly expensive to drill: just the drilling activity can cost \$100 million per well. In addition, costs tend to rise with water depth – and the average water depth of production in Brazil increased by threefold between 1995 and 2015. This subsection examines how the substantive capital investments demanded by offshore oil production can be leveraged for active industrial policies through direct government procurement, using the example of Brazil's naval industry. Government activism was responsible for mobilizing public and private capital for new investments in this sector, even though the industry struggled to reach international competitiveness levels and slowed down Petrobras' production growth due to delivery delays.

About 90% of Brazil's oil production comes from offshore operations. Some of the goods used in the production chain of offshore oil includes offshore drilling rigs to locate reserves, semi-submersible or floating platforms to produce O&G, and platform supply vessels (PSVs) to support offshore operations with equipment and cargo, and tankers to transport production. All of them are assembled in shipyards where the main processes are the cutting and welding of steel plates and installation of modules and equipment following carefully specified engineering plans. Production is modular – the hull of a platform can be built in one facility, for example, Geoje in South Korea, while the integration of the equipment that goes inside the platform (called topsides, in the industry lingo) can be done in another site, such as Rio de Janeiro, Brazil.

The growth of the demand for offshore equipment in Brazil and the modularity of the naval industry – which allows to gradually build capabilities – created a fertile ground for an active industrial policy based on direct government procurement, subsidized loans and exploration and production contracts that included increasing levels of offshore equipment with LC requirements. Furthermore, the rise of the Worker's Party (PT) to power brought active industrial policies again to the policy agenda. To their benefit, PT policymakers had at their disposal decades-old industrial policy instruments such a development bank (BNDES) and a specific fund to support the naval industry (the Marine Merchant

Fund, created in 1958). The icing on the cake was that shipyards are labor-abundant operations, generating thousands of jobs in a single production facility, a politically important factor, particularly for a party that has a constituency on metal mechanic workers such as the PT.

That combination led policymakers to devise incentives to upgrade existing shipyards and attract big Brazilian business groups (like Queiroz Galvão, Camargo Corrêa, Odebrecht), along with international technology partners (Samsung, IHI, Daewoo, Kawasaki, etc.), to invest in new facilities. This included subsidized funding and guaranteed orders from Petrobras. In addition, when LC requirements were broadened to include offshore equipment, oil concessionaries were subject to fines if they did not use Brazilian shipyards in their projects. Petrobras actively participated in sponsoring new shipyards by devising a specific program to renew its fleet of oil tankers through the Fleet Modernization and Expansion Program (Promef) (Petrobras 2013). It also supported the creation of Sete Brasil, a company built in 2010 with public and private money with the goal of developing Brazilian suppliers of the very expensive deep offshore drilling rigs. These programs were branded as initiatives to promote the resurgence of Brazil's naval industry. Brazil had ranked among the top 3 in the world production of the naval industry in the mid-1970s, during the height of the development programs of Brazil's military regime (1964-1985), only to drastically fall in the 1980s (Baraf et al. 2014, Petrobras 2013).

Promef was designed by Petrobras to replace its old leased fleet of tankers with a new fleet that would be built to current standards (double-hulled) in Brazilian shipyards, with a minimum LC of 65%. The rationale was that procuring a package of 49 new oil tankers would provide enough scale to interest Brazilian firms in investing in the sector, with total investment of R\$11 billion, or about \$3.5 billion (Campos Neto and Pompermayer 2014). The program recognized that the first ships would have higher than prevailing international prices and longer delivery times, but the assumption was that by the end of the process the local shipyards would have moved along a learning curve that would put them on equal footing with foreign suppliers. Similarly, Sete Brasil planned to build in Brazil a package of 29 drilling rigs. At the time the program was conceived, lease prices for drilling rigs were at record levels, at about US\$500,000 per day, and at such high prices new entrants could be attracted to the market. It was estimated that the construction would require investments of US\$26 billion, generating up to 120 thousand direct and indirect jobs (Sete Brasil 2016). The perspective of becoming a supplier for Promef and Sete Brasil led to rounds of investments in shipyard capacity.

In less than a decade, Brazil's position in the world rank of the naval industry jumped from 18th, with 0.2 million gross tonnage in 2004, to fourth, with more than a tenfold increase to 2.3 million gross

tonnage (Clarkson Research Services 2012), though still far behind the Asian leaders of China, South Korea and Japan (see Table 4.3). However, unlike those producers, which cater to the world market, Brazil's growth was entirely a result of public policies linked to increasing installed capacity of shipbuilding to serve the local market of offshore oil. A study by researchers from the Institute of Applied Economic Research (IPEA) with data from 2000 to 2013 painted a positive picture of the sector's development, concluding that the public policies used to boost the industry (subsidized funds, government procurement and protectionism) were appropriate (Campos Neto and Pompermayer, 2014).

Table 4.3: Major shipbuilders by compensated gross tonnage (2011)

Country	Million CGT
China	49.4
South Korea	42.2
Japan	16.7
Brazil	2.3
Taiwan	1.4
Germany	1.3
Italy	1.1
Turkey	0.9
Netherlands	0.7
Norway	0.6
USA	0.5
Croatia	0.4
France	0.3
Spain	0.3
Finland	0.3
Poland	0.2
Total others	10
Global total	128.6

Source: Clarkson Research Services (2012)

However, unlike China and South Korea which clustered their naval industry in specific areas, benefiting from economies of agglomeration effects, the Brazilian policy spread shipyard facilities throughout the country's large coast. The government sponsored the creation of more than a dozen new facilities from the Northeast to the South, with many units in-between (Petrobras 2013; see a map in Figure 4.9 in the Annex 2). While it makes good politics, as more states benefitted from jobs and

capital investments driven by the demand from the oil sector, this strategy made even more difficult to reach international levels of competitiveness (Almeida et al. 2014).

An audit report (TC 025.692/2013-5) produced by the Federal Audit Court (TCU) on Promef revealed the magnitude of the productivity gap of the domestic industry. The report showed that Petrobras overestimated the productivity gains that would be achieved by its new suppliers, creating additional costs to this industrial policy. For instance, the EAS shipyard, the biggest in the country, was built only after winning an order from Promef to deliver ten “Suezmax” ships (the same firm later also got other contracts for Petrobras and Sete Brasil). However, the first Suezmax was delayed by 623 days. Because of the sequential nature of construction, the delay in the first ship affected the production of the remaining ones, although not by the same extent. Productivity levels measured as output per labor hour of the first two Suezmax at EAS were a third of what had been specified in the contract. More generally, Silva (2014) shows that the worker productivity in Brazilian shipyards are half of China’s and one eighth of Korea’s, and estimates 36% cost disadvantage, on average, of producing oil tankers in Brazil.

Petrobras’ production targets were negatively affected by considerable delays from local shipyards (Campos Neto 2014), as areas that could be put into production were on hold waiting for the completion of production platforms. To speed up deliveries, the company developed a program to monitor shipyards closely, and encouraged measures to increase productivity and improve engineering and management practices (Pires et al. 2013, interview Bastos 2015). When these corrective measures were insufficient, the NOC cancelled orders from local shipyards and turned instead to Chinese suppliers, as it did in 2013 when orders from two Brazilian shipyards were transferred to the Chinese Cosco (Valle 2013).

Data from the association of the naval industry, Sinaval, shows that employment levels in the sector had boomed from 2004 to 2014, reaching the peak of 82 thousand direct employees in 2014 (Figure 4.8). For comparison purposes, this represented more than half of all direct employees of the Brazilian auto sector for the same year, which was 144 thousand (Anfavea 2015). After the peak, employment levels began to fall as the lower oil price scenario and Petrobras’ own financial problems resulted in a reduction of orders. Furthermore, Sete Brasil, which was designed to fulfill the executive vision of making Brazil a world leader in offshore equipment manufacturing, such as drilling rigs, filed for bankruptcy protection in June of 2016.

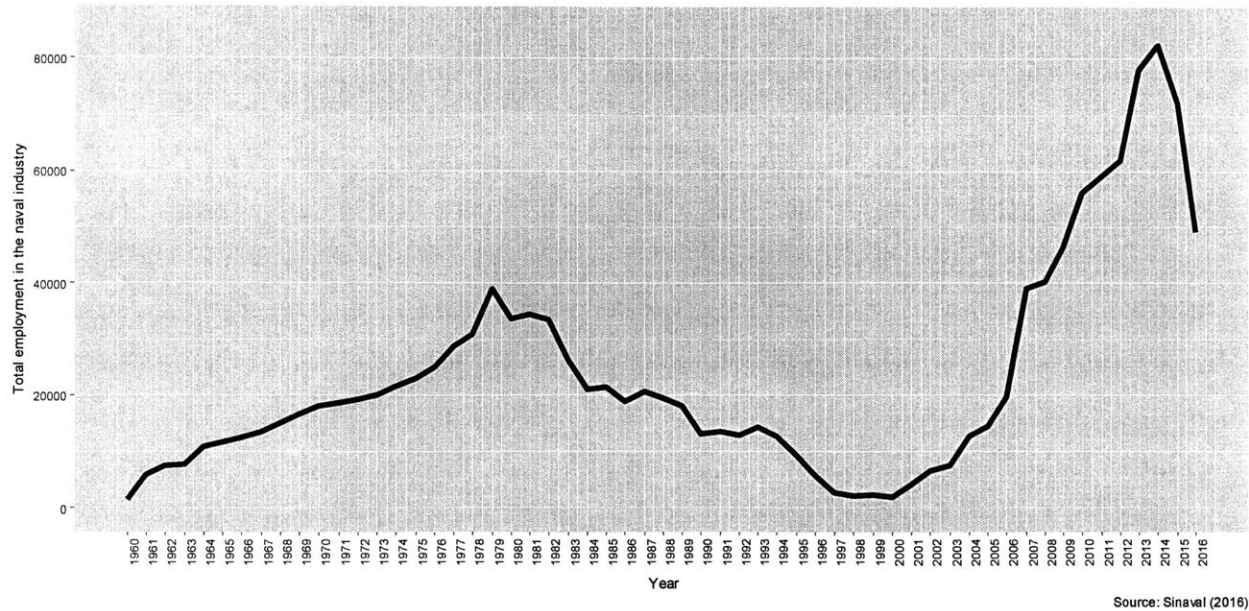


Figure 4.8: Total employment in shipyards in Brazil (1960-2016)

Brazil's recent industrial policy experiment in promoting the resurgence of its naval industry deserves an evaluation of its own in terms of the merits and design choices.⁸³ For the specific purposes of this study, the growth of the naval industry in Brazil highlights how oil production in this country followed a different political logic than what has been observed in conventional oil producers such as Mexico, which outsourced the development of its main field, Cantarell. In Brazil, the rules of the oil sector were designed to serve the growth of the industry along the value chain, even at the expense of faster oil production growth and its associated rents.

5. Conclusion

Created in 1953 with a mission to find and develop oil and gas reserves in Brazil, Petrobras had to overcome a geological challenge: Brazil proved to be a country without easily accessible and low cost onshore resources. Its offshore areas showed more potential, but to tap these resources it would be necessary to master the technological frontier of the O&G industry. Consequently, Petrobras was not a NOC founded to manage plentiful rents from easy oil production, but rather it has been a company that

⁸³ Because this goes beyond the scope of this dissertation, the reader can consult other sources (e.g., Almeida et al. 2016, Campos Neto and Pompermayer 2014, Petrobras 2013, Pires et al. 2013).

required creating rents, through Schumpeterian innovation, to thrive. It had grown throughout the years and increased domestic production by investing heavily in R&D, managerial capabilities and human resources. Quite deservedly, the company has been singled out as one of the successful cases of Brazil's uneven developmental state record (e.g. Schneider 2015b).

Despite an established record of technical accomplishment and yearly production growth, by mid-1990s Petrobras was still producing about half of Brazil's O&G consumption. Its monopoly condition constituted a barrier for growth, since the company could not share geological risks with partners and have access to the capital necessary to fund, in a greater scale, investments in deep offshore projects. Deep offshore exploration and production are not only costly activities, they also require longer term-horizons. From exploration to the first oil production it can take ten years, a long period where the investors have to bear a negative cash flow (Jahn et al. 2008). To fund projects that have high geological risk and a long payback period is particularly challenging if a company has to rely on retained earnings or direct public funding, having to compete with other public budget priorities and incentives arising from shorter political cycles.

To surpass those regulatory challenges, the government headed by Fernando Henrique Cardoso (1995-2002), who came to power backed by a pro-market reformist coalition, sponsored a constitutional amendment (Number 9/95) that opened the sector for private investors. Two years later, Congress approved a new legal framework (Law 9478/97) that established an independent regulatory agency (ANP) in charge of overseeing the sector and conducting frequent bidding rounds for exploratory areas. The new legislation, and its subsequent development, also consolidated in formal rules, and extended to private players, practices that Petrobras used to do by itself during the monopoly years: investment in local universities and in developing suppliers. This has been done by legally earmarking oil rents to R&D (1%) and through the adoption, in all bidding rounds, of contractual clauses regarding local purchases – a move initiated by the pressure of business associations that feared that private operators would sideline Brazilian firms in their procurement strategy.

LC requirements are part of Brazil's legal framework since the first bidding round in 1999. However, the definition of what constitutes LC became stricter and its weight in the regulations has increased over the years in response to political pressures by business associations and stronger industrial policy activism by the executive, particularly during the tenures of president Luiz Inácio Lula da Silva (2003-2010) and Dilma Rousseff (2011-2016). In a process that involves public hearings and meetings with the industry stakeholders, LC started as an incentive in bidding rounds and shifted to

mandatory – from carrot to stick. Through consultation with suppliers, the government increased the minimum LC targets and made the commitment to be highly detailed and inclusive, specifying at the subcomponent level how much LC an equipment has to have. In order to enforce the requirements, policymakers gave the oil and gas regulator capacity to monitor LC compliance through a system of certification of suppliers as well as legal authority to issue (large) fines when contractual targets are not met by operators.

Oil companies reacted mainly in two ways. First, for the blocks already acquired, companies took the rules as given and started working with suppliers, evolving from areas of procurement to LC development. This work included closely monitoring suppliers and transferring capabilities, to minimize fines, or documenting situations of excessive price to base a waiver request made to ANP. Second, oil companies attempted to influence the policymaking process by voicing their concerns about the cost of compliance of the LC policy, particularly through their industry representative, the Brazilian Institute of Petroleum (IBP). Their defense of a less rigid and lower LC regime found strong opposition in industry associations that have suppliers as main members (e.g., Coelho 2017).

Brazil's rules of distribution of oil wealth are the result of a bargaining process between lawmakers, the executive and interest groups. Throughout most of its history, oil rents have been marginal to the national economy, with the legal rules focused on increasing production and channeling the growth of the oil industry to scientific and industrial demand. With the discovery of the pre-salt formation, an ultra-deepwater area characterized by having large resources, lower geological risk, and high cost of production, policymakers were freed from the constraint of oil scarcity, given the availability of new reserves. However, the pre-salt is also one of the most technically complex and costly oil resources to produce in the world. This combination led to a new legal regime that combined increased demand for rent-capture with the strong distributive pressure for LC. In this *Saudi Arabia-like of the deep offshore*, a key variable to determine the rate of expansion was set to be, in law, the capacity of the domestic supply chain. From the rents and industrial spillovers coming from the O&G production Brazil would find its passport to the future, claimed president Lula da Silva.

The low oil price scenario that started in late 2014 changed the bargaining power of oil companies: it raised the credibility of their threats of not investing due to the costs of the LC requirements (Almeida et al. 2016). Hence, in a lower margins reality it became unfeasible to both promote high rent-capture and redistribution through contracts. The deputies and senators in the Congress have sponsored, since 2013, bills that ended Petrobras' monopoly of operation of the pre-salt,

which was eventually approved and signed into law in 2016. The executive also made the LC requirements lower and more flexible, but still keeping it mandatory with fines for non-compliance (Otta 2017). Geological challenge is, thus, a key variable to understand Brazil's oil politics centered on investment in innovation, oil contracts, and increased rent-seeking after the discovery of large resources – the latter point which will be explored in the next chapter.

Annex 1: Commitment to Local Content – Production-Sharing Contract (2013)

The Contracted Party undertakes to comply with the following minimum percentage of Local Content in the acquisition or procurement of goods and services aimed for fulfilling the purpose of this Contract:

Exploration Phase			
Subsystem	Item	Minimum Local Content item (%)	Minimum Local Content - Exploration Phase (%)
Operational Support	Logistical Support (Sea/Air/Base) (Note 1)	50	37
Geology and Geophysics	Acquisition	5	
	Interpretation and Processing	85	
Drilling, Assessment and Completion	Deep- Water Drill	29	
	Drilling + Completion (Note 2)	45	
	Auxiliary Systems (obs. 3)	54	
Long Duration Test	(note 4)		15

Production Development Phase - modules with first oil up to 2021			
Subsystem	Item	Minimum Local Content item (%)	Minimum Local Content - modules of the Development Phase (%)
Drilling, Assessment and Completion	Deep- Water Drill	50	55
	Logistical Support (Sea/Air/Base) (Note 1)	50	
	Christmas Tree	70	
	Drilling + Completion (Note 2)	37	
	Auxiliary Systems (obs 3)	58	
	Distribution Lines	Flexible	40

Production Collection System		Rigid	80
	Basic Engineering		90
	Detailed Engineering		90
	Management, Construction and Assembly		34
	Flexible Production/Injection Lines (Flowlines, Risers)		56
	Rigid Production/Injection Lines		50
	Manifolds		70
	Subsea Control System		20
	Umbilical		55
UEP	Hull	Basic Engineering	90
		Detailed Engineering	90
		Management	90
		Construction and Assembly	75
		Commissioning	90
		Systems and Equipment	40
		Naval Systems	50
		Materials	80
	Plants (note 5)	Basic Engineering	90
		Detailed Engineering	90
		Management	90
		Construction and Assembly	75
		Commissioning	90
		Systems and Equipment (note 5.1)	57
		Materials	80
	Basic Engineering	90	
	Detailed Engineering	90	

	Installation and Integration of Modules	Management	80
		Construction and Assembly	75
		Naval Means	10
		Commissioning	75
		Materials	75
	Anchoring	Pre-Installation and Hook-up of lines	40
		Anchoring Systems	85

Production Development Phase - modules with first oil as of 2022				
Subsystem	Item	Minimum Local Content item (%)	Minimum Local Content - modules of the Development Phase (%)	
Drilling, Assessment and Completion	Deep- Water Drill	65	59	
	Logistical Support (Sea/Air/Base) (Note 1)	60		
	Christmas Tree	70		
	Drilling + Completion (Note 2)	37		
	Auxiliary Systems (obs 3)	58		
Production Collection System	Distribution Lines	Flexible		40
		Rigid		80
	Basic Engineering	90		
	Detailed Engineering	90		
	Management, Construction and Assembly	34		
	Flexible Production/Injection Lines (Flowlines, Risers)	56		
	Rigid Production/Injection Lines	50		

	Manifolds	70	
	Subsea Control System	20	
	Umbilical	55	
UEP	Hull	Basic Engineering	90
		Detailed Engineering	90
		Management	90
		Construction and Assembly	80
		Commissioning	90
		Systems and Equipment	40
		Naval Systems	50
		Materials	80
	Plants (note 5)	Basic Engineering	90
		Detailed Engineering	90
		Management	90
		Construction and Assembly	80
		Commissioning	90
		Systems and Equipment (note 5.2)	58
		Materials	80
	Installation and Integration of Modules	Basic Engineering	90
		Detailed Engineering	90
		Management	85
		Construction and Assembly	80
		Naval Means	10
		Commissioning	80
		Materials	75
	Anchoring	Pre-Installation and Hook-up of lines	50

	Anchoring Systems	85
--	-------------------	----

Observations

(1) In the composition of the local content measured for the logistical support, in the Exploration Phase and in the Production Development Phase, the following specific contents should be considered:

Sub-items	Exploratory Phase	Production Development Phase up to 2021	Production Development Phase as of 2022
Marine Support	50	50	50
Air Support	50	50	50
Terrestrial Support	80	80	80

(2) In the composition of the local content measured for drilling, evaluation and completion, in the Exploration Phase and in the Production Development Phase, the following specific contents should be considered:

Sub-items	Exploratory Phase	Production Development Phase up to 2021	Production Development Phase as of 2022
Drills	5	5	5
Wellhead	60	60	60
Production Columns	24	32	32
Well Equipment	50	50	50
Lining	73	73	73

(3) In the composition of the auxiliary systems the following sub-items should be considered:

Sub-items	Exploratory Phase	Production Development Phase up to 2021	Production Development Phase as of 2022

Field Tools	40	40	40
Automation System	60	75	80
Tax Measurement System	60	60	60
Telecommunication System	40	40	40
Electrical System	70	70	70

(4) This item is highlighted for the Exploration Phase, so both the investments as the CL related indexes should be treated separately from the investments and indexes referring to the Exploration Phase. Includes the sum of expenses with chartering and production unit operation or deep see drilling, services, materials and production equipment used in the wells for the TLD (production column, ANM and others), lines and risers of production, offloading, support logistics to the production system and services for the incorporation of the acquired data.

(5) This item is composed of: processing plant, gas moving and water injection plant.

(5.1)

Production Development Phase - modules with first oil up to 2021		
Equipment		Minimum Local Content (%)
Boiler Forge	Ovens	80
	Tanks	83
	Pressure Vessels	70
Field Tools		40
Static Mechanics	Filters	80
	Cathodic Protection	90
	Burners	14
	Valves (up to 24")	58
Rotating Mechanics	Pumps	70
	Rotating Mechanics - Alternative Air Compressors	70
	Rotating Mechanics - Screw Air Compressors	70

	Rotating Mechanics - Diesel Engines (up to 600 hp)	65
	Rotating Mechanics - Gas Turbines	35
	Rotating Mechanics - Steam Turbines	80
Automation System		75
Tax Measurement System		60
Telecommunication System		40
Electrical System		70
Processing Tower		75
Cooling Tower		85
Heat Exchangers		50

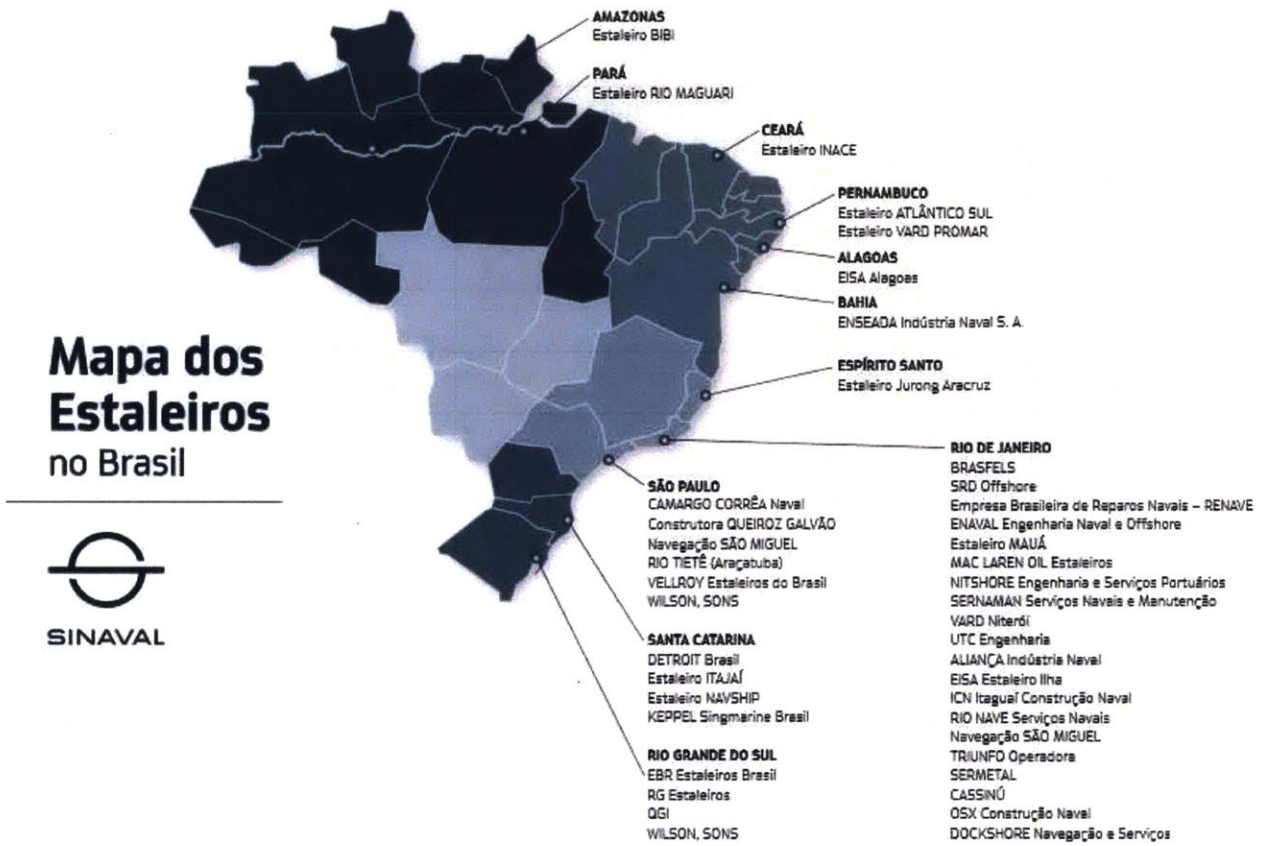
(5.2)

Production Development Phase - modules with first oil as of 2022		
Equipment		Minimum Local Content (%)
Boiler Forge	Ovens	80
	Tanks	83
	Pressure Vessels	70
Field Tools		40
Static Mechanics	Filters	80
	Cathodic Protection	90
	Burners	14
	Valves (up to 24")	68
Rotating Mechanics	Pumps	75
	Rotating Mechanics - Alternative Air Compressors	70

	Rotating Mechanics - Screw Air Compressors	70
	Rotating Mechanics - Diesel Engines (up to 600 hp)	70
	Rotating Mechanics - Gas Turbines	35
	Rotating Mechanics - Steam Turbines	80
Automation System		80
Tax Measurement System		60
Telecommunication System		40
Electrical System		70
Processing Tower		80
Cooling Tower		85
Heat Exchangers		55

Source: ANP (2013)

Annex 2:



Source: Sinaval (2014)

Figure 4.9: Map of shipyards in Brazil as of 2014

Chapter 5:

Petrobras: Innovation with Party Rent-Seeking

1. Introduction

Brazil has about 130 federal state-owned companies (DEST 2016, p.15), many of which directly execute social and developmental programs of the government. For instance, the public bank Caixa Econômica manages the *Bolsa-Família*, one of the best known conditional-cash transfer programs in the world and the flagship social program of the Luiz Inácio Lula da Silva administration (2003-2010) (Sugiyama and Hunter 2013, Zucco 2013). Another key institution is Brazil's National Development and Social Bank, BNDES, the largest development bank in Latin America and one of the biggest in the world, which is Brazil's main source of long-term capital for firms (Coutinho et al. 2012). One more example is Banco do Brasil, which is both a large commercial bank and a major source of subsidized rural credit. All these and other state companies feature prominently in presidential speeches, as the country's top politician travels the nation to attend rallies to launch government programs and participate in ribbon-cutting ceremonies.

An observer of Brazilian politics who listened to presidential speeches during Lula da Silva's administration would hear more about Petrobras than any other state company and even more than a social program like *Bolsa-Família* (see Figure 5.1).⁸⁴ As the company used its capital expenditures to build new refineries, and petrochemical plants and support the growth of the domestic shipbuilding capacity, the latter following local content policies for the oil and gas (O&G) sector, the president would fly and deliver speeches on construction sites, meet with workers, and bestow his support for local politicians. Unknown to the public at this time was that Petrobras was providing much more than opportunities for credit-claim: many of the large contracts carried bribes that varied from 1% to 3% and were channeled to political parties of the ruling coalition in a scandal that came to be known as *Petrolão*. As the scandal unfolded, references to Petrobras vanished from presidential speeches, as occurred during Dilma Rousseff's tenure, which ended by an impeachment procedure in 2016.

⁸⁴ Analysis based on all the speeches made by presidents Luiz Inácio Lula da Silva (2003-2010) and Dilma Rousseff (2011-2016) during their respective tenure, totaling 3115 speeches, of which 2156 pertain to the former and 959 to the latter. The data was scrapped from the site of the presidency, cleaned, and analyzed on the references made to state companies and social programs and their context. Figure 5.1 shows, as proportion of total speeches per year, the most cited state-owned companies, and the country's main social and development programs (*Bolsa-Família*, a conditional-cash transfer program, Pronatec, a vocational training program, and the Growth Acceleration Program, PAC, a public investment package).

Petrobras was at the center of Brazilian politics during the last 15 years. It generated jobs along the supply chain and increased the productive capacity in the manufacturing of sophisticated goods in the country. It also supported human resources and scientific development by funding student scholarships and new research facilities throughout the country. Operating next to these public achievements was a network of corrupt contractors, executives and politicians who used the growth of investment capacity for personal and political gains, with bribes reaching \$2 billion in value between 2004-2012.

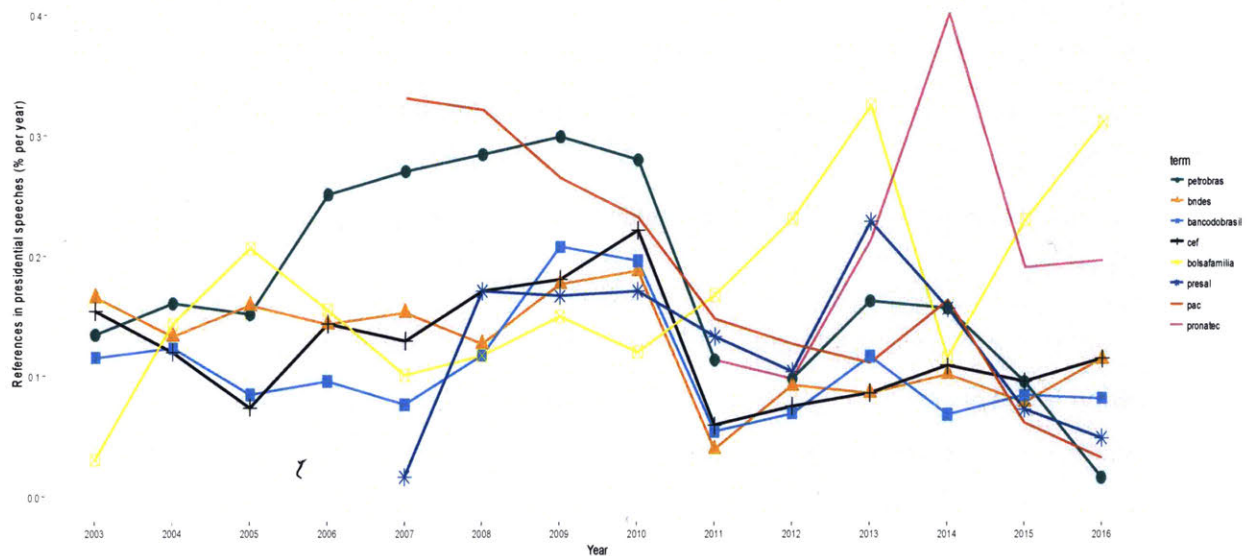


Figure 5.1: References to state companies and social programs in presidential speeches

This chapter seeks to answer two questions. First, how did Petrobras, which has been a model National Oil Company (NOC) for the professionalism of its management and its innovation activities, become the center of a corruption ring if there was no institutional reversal in its governance and oversight? Second, what was the effect of the local content industrial policy, which drove Petrobras to increase its domestic purchases, in the corrupt activities within the company?

These are important questions that relate to the literatures on management of natural resources, state-owned companies and industrial policy. If formal institutions that impose transparency requirements and separate policymaking, regulatory and commercial functions within the natural

resource sector are key to avoid public predation and sustain investments (Barma et al. 2012, Thurber et al. 2011), we should not expect Petrobras to have become more corrupt over time, since institutional quality remained the same. Furthermore, a related issue is that once the management of the company started to serve as a vehicle for corrupt activities, the theoretical expectation, from the rent-seeking literature, is that its innovation activities would be harmed, as rent-seeking is deemed to be detrimental to innovation. Therefore, the first question to answer is what has changed and how was it possible for Petrobras to have its most successful period – reaching production self-sufficiency for the country and finding new reserves – at the same time that it was run by a corrupt management.

The second question deals directly with a key prediction that comes out of the theoretical framework developed in Chapter 2, which are the characteristics of local content in the upstream as a novel type of industrial policy. Critics of industrial policy point out that such government interventions create more opportunities for rent-seeking. This would lead to an expectation that corruption within Petrobras would be higher where it had to follow local content requirements. On the other hand, if the reasoning advanced in Chapter 2 is correct, local content as an industrial policy is more likely to constrain rent-seeking because of the competitive nature of the goods supplied (internationally traded goods) and the lower margins of operation of oil companies that extract from unconventional resources.

The answer to the first question lies in the mixture of rent-creation, through innovation required to reach Brazil's deep water reservoirs, and rent-seeking, an unusual combination that characterizes the recent development of Brazil's oil sector. A geological challenge propelled Petrobras to innovate and increase its production and reserves. This success created enough surplus to attract rent-seeking behavior by political parties, suppliers and its own employees. Consequently, politicians in Brazil were interested in both promoting innovation and appropriating the rents from it – but the latter came only after years of investment in technological capacity. This goes in the opposite direction of rent-seeking models which assume that rent-seeking uses inferior technologies to facilitate transfer to private actors (Tullock 1990) or that rent-seeking is linked to lower innovation activities (Murphy et al. 1993). Instead, the argument defended in this chapter is that Petrobras' rent creation through Schumpeterian innovation in ultra-deep water resources increased its usefulness for political actors. In their turn, political actors with access to the rents created by Petrobras recognized the importance of sustaining innovation in the O&G sector. Therefore, innovation was actively promoted in the distributive rules of the oil sector (such as earmarking rents to R&D) and within Petrobras since it has been vital to support the company's other activities, which later included politically-driven investments, illegal funding to

political parties, and gasoline price subsidies driven by political reasons. The evidence corroborates the argument that the driving force behind Petrobras' success as a NOC was the context in which it operated, its geological challenge, rather than just national level institutions that supposedly constrained political meddling.

In this chapter, I also take the theoretical predictions developed in Chapter 2 to elaborate on the distinct effects on innovation and distributive pressures for the upstream, where local content requirements have been adopted in exchange for access to reserves, and the downstream segments. While corruption took place in all segments of the company, I show that it was much higher in the downstream (e.g. refining) than in the upstream (extracting oil) – supporting the prediction that competitive pressures are higher in the upstream for high-cost producers. Not only was the bulk of innovation of Petrobras concentrated in the upstream, as addressed in the previous chapter, but bribe rates were lower in this segment at the same time that the financial gains it generated for the company were higher. Furthermore, contractors in the upstream lost orders when they failed to meet deadlines, as happened to shipyards. In comparison, bribes and financial losses were higher in the downstream segment, which is explained by its more intense distributive demands that take the form of energy subsidies and politically motivated investments of refineries and petrochemical plants.

This chapter shows that in the mid-2000s there was a brief moment where key historical characteristics of Petrobras changed: production increased making the country virtually self-sufficient (a feature celebrated in 2006, albeit prematurely), with the perspective of becoming an important exporter in the near future given large discoveries in the pre-salt oil province, at the same time that high oil prices increased its margins of operation. Together, these factors abolished Petrobras' traditional hard budget constraint that had spared it from serving as a tool for patronage and mismanagement and changed Brazil's oil political economy. Institutions were the same, but some of the political incentives changed.

This chapter is structured as follows. In Section 2, I further elaborate a theory of innovation in the natural resource-sector that connects geological endowments with political incentives, firm behavior and distributive rules of oil wealth, with particular attention to distinct effects according to the industry segments, i.e., upstream and downstream. Section 3 addresses the corruption scandal of Petrobras, the political preferences of Petrobras' suppliers as revealed by campaign donations, and it provides quantitative tests of losses by segments. Finally, Section 4 concludes and discusses the implications of the findings.

2. Geological endowments, innovation, and political incentives in the upstream and downstream

This section will advance two arguments based on a theory that connects geological endowments with political and business incentives. Building on the previous chapter, I argue that because of Brazil's geological endowment, policymakers had an incentive to invest in rent-creation strategies in the upstream, departing from the conventional case of oil wealth serving as a source of easy rents that are captured by governments. Second, I show that distributive pressures in the oil sector vary by segment (the upstream and downstream) and unpacking them are critical to understand the sources of losses and political mismanagement in oil companies.

The analysis presented in Chapter 2, on the different sources of rents and the role of innovation in the natural resource sector, allows us to derive clear expectations of the incentives that governments in countries with different resource endowments, and abilities to exploit different types of rents, will have. A government in a country that has abundant, easily accessible resources with low cost will have the most to gain, in monetary terms, by maximizing rent capture: taxing the O&G sector highly and if possible coordinating to restrict output. At the other extreme, a government of a country that is just marginally profitable in the production of such natural resource will have no rent to extract – high taxes cannot be charged or production will cost more than sales price. In addition, such a marginal producer has no market power to influence world prices (no monopoly rents).

Consequently, policy makers of a less well-endowed country have few options to stimulate its domestic oil industry. Considering that geology is given by nature and its production is small enough so it cannot influence prices, and therefore both geology and prices are exogenous to domestic actors, the only variables that can partially be influenced by public policy are technology, tax levels and institutions that can reduce production costs and mitigate investment risks. A government of a nation abundant with a resource that has high cost of production, rather than striving to capture rents, will first have an incentive to create rents through R&D, innovation and complementary investments – directly and/or through its agent (a NOC). It is worth noting that under conditions of high-cost production, industrial demand becomes much more important because more money can be exchanged in the form of industrial and service contracts than in rents distributed by governments, particularly when selling prices become closer to break-even levels. This demand will be politically important as local supplier firms will have an incentive to lobby for rules that mandate that oil companies prioritize them in their procurement, what has increasingly taken the form of local content (LC) requirements as conditions to access exploratory areas (Lima-de-Oliveira 2016, Tordo et al. 2013).

Those distinct geological endowments and associated industry characteristics create incentives for political actors who are involved in setting the rules of the natural resource sector. The executive branch, as manager of national resources, is the first affected by these incentives. However, the executive faces political constraints that can be either distributive pressures, or veto points from the legislative action (Krehbiel 1998, Tsebelis 1995), or both.⁸⁵ Resource endowments (volume of reserves and cost of production) provide direct incentives for the executive, which is interested in the revenues from oil production, and also affect interest groups by shaping their distributive demands and expectations about future costs and benefits. Considering that in high-cost oil production the demand for capital goods and services is higher, it is likely that pressures to include local suppliers in the production chain in the form of LC mandates will increase. Those mandates are not, in any way, necessary for the development of high-cost oil, and they may even be detrimental to it in terms of time and cost overrun. However, I expect it to arise due to the political benefits that such policy can confer to firms and lawmakers.

These incentives are related to the upstream part of the production chain – getting oil out of the ground at cost-competitive prices. However, (integrated) oil companies do more than just extracting oil: they can transport it (midstream), refine and transform into petrochemicals (downstream). Significant rents exist in the upstream (Tordo et al. 2011) but as the value chain moves from the discovery and production of oil to transformation (downstream), the market becomes more competitive and the margins tighter: a refinery essentially receives a commodity as feedstock (barrels of crude) and produces other commodities. Demand for technology is also lower, as the transformation process can use off-the-shelf technologies. On the other hand, distributive pressures can be very high and come from two main distinct sources: subsidized domestic energy prices, which are common in oil-rich countries (Cheon et al. 2013) and investments in refineries and petrochemical plants according to political convenience rather than technical feasibility, sometimes branded as regional development efforts (Ascher 1999).⁸⁶

To sum up, resource endowments vary in their characteristics, rents per unit of output, and what it takes to extract them. All these generate political incentives on how to structure the rules of the resource sector and the behavior of oil companies. Where natural resources are abundant and easy to extract, there will be little incentive to improve the efficiency of production or invest in technology or

⁸⁵ For instance, a coalition that is concerned about environmental impacts from unconventional oil production and is powerful enough to serve as a veto point can block production from this source of oil.

⁸⁶ While in the upstream oil production requires the existence of a reservoir in the first place, a refinery or a petrochemical plant can be disputed by different regions and political groups.

the supply chain. On the other hand, where resources exist but rents are few, an institutional arrangement to support rent-creation will facilitate the development of the natural resource sector.

These are expectations across countries (between high-rent versus low-rent producers) and across time (as a country shifts its geological endowments). Furthermore, I also derive expectations for within industry sectors. Downstream operations lack the geological constraints that exist in the upstream and their innovation incentives. Additionally, it is more subject to political pressures in the form of domestic price subsidies and in its investment decisions. Table 5.1 summarizes the theoretical expectations concerning innovation and distributive pressures by resource type and industry segment:

Table 5.1: Industry segment, innovation and distributive pressures

		Upstream		Downstream	
		Incentives for innovation	Distributive pressures	Incentives for innovation	Distributive pressures
Conventional	Low, production is competitive with standard-technology due to favorable geology	Low from suppliers (low capital investments), high from internal stakeholders (employees)	Low, tight margins and commoditized production	High, localization of investments and cheaper energy prices. Limited by production capacity and (lower) reinvestment needs	
	High, needs to access complex reservoirs and reduce costs to stay on the market	High from suppliers (high capital investments) and low to moderate from internal stakeholders (limited by cost pressures)	Low, tight margins and commoditized production	High, localization of investments and cheaper energy prices. Limited by production capacity and (higher) reinvestment needs	
Unconventional					

Chapter 4, which addressed Petrobras' innovation strategies over the years, showed that the company concentrated its R&D efforts in the upstream to develop deep-water capabilities required to find and exploit new reserves, providing support for the expectation regarding innovation incentives per segment. To test the predictions on distributive pressures and rent-seeking developed above, I examine the origin of the Petrobras' corruption scheme and how it varied across industry sector. If the hypotheses advanced in this section are correct, that in the downstream segment distributive demands and rent-seeking are higher, we should expect financial losses and corruption to be lower in the upstream, despite being the only segment with a contractual requirement to purchase domestically manufactured goods (local content).

Before turning to an analysis of the corruption scandal, it is important to highlight the impressive growth of Petrobras' investment capacity in the mid-2000s and the expenditure per

segment, which is done in Figure 5.2. From 2004 to 2015, Petrobras invested \$335.848 billion (in real, 2015 dollars), almost four times what it did in the previous 50 years of its history, which sums to \$87.3 billion. However, not only did Petrobras boost investments in petroleum exploration and production (E&P), as would be required to develop the newly found resources of the pre-salt, but also in all other areas of the company, notably downstream, electrical energy, petrochemical and international investments. In fact, the share of upstream investments decreased from a peak of 92% registered in 1984 to a low of 42% in 2010 - the smallest share since 1976.

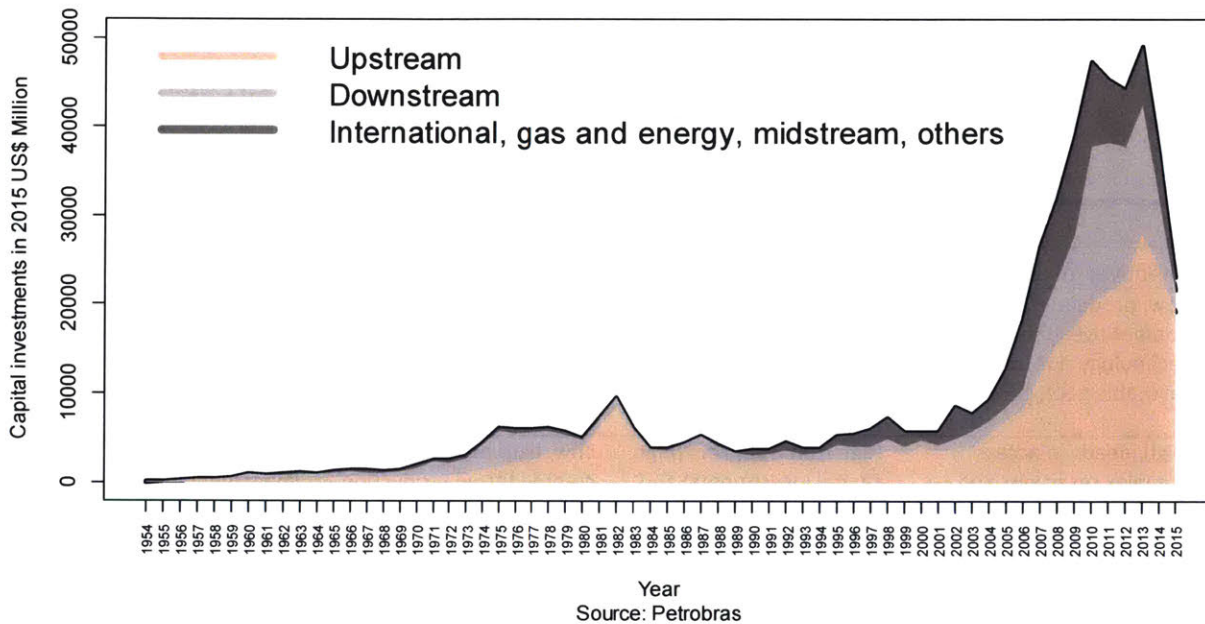


Figure 5.2: Total investments by Petrobras (1954-2014) in 2015 US\$

As will be addressed next, not only these impressive investments were boosting the domestic capacity to produce and refine barrels of oil, but were also serving to attract parties to the ruling coalition by helping them raise money for political campaigns and allowing their political appointees to collect bribes.

3. Oil rents greasing the wheels of coalitional presidentialism

3.1. The “Carwash” operation

In March of 2014, the Brazilian Federal Police started to investigate a money-laundering scheme that was based in a fuel station. The operation was dubbed “Carwash” and led to the temporary arrests

of politicians, company executives, and bagmen, with intense press coverage. The investigation revealed that a former director of Petrobras, Paulo Roberto Costa, had close ties with Alberto Yousseff, the actual target of the investigation and responsible for running a money-laundering and bribe scheme that connected contractors to politicians and Petrobras executives. After being arrested, Costa and Yousseff negotiated plea bargains with public prosecutors and decided to reveal the full extent of the scheme, leading to further arrests, including some of the wealthiest businessmen in Brazil. Each new round of the police operation led to more arrests, with some executives and CEOs of companies deciding to collaborate in exchange for reduced sentences. A notable case was of Pedro Barusco, from Petrobras, who agreed to return \$100 million he had in a Swiss bank account.⁸⁷

The operation revealed a cartel of construction companies that overcharged Petrobras in exchange for paying bribes ranging from 1% to 3% of the total contract amount. In an elaborate scheme that lasted for years, executives of big national construction companies held periodic meetings to fix public biddings. A share of the overcharged amount would then be split between senior managers of Petrobras and political parties. This was made possible because, starting with Luiz Inácio Lula da Silva's administration (and persisting under his successor, Dilma Rousseff), political parties of the governing coalition were put in charge of appointing senior managers of the company.

With few exceptions, the management of Petrobras continued to be run by highly qualified longtime employees who entered through open, competitive examination. However, in order to reach and hold a position of direction, an employee had to court the active support of a political party, such as the Worker's Party (PT), the Brazilian Democratic Movement Party (PMDB), and the Progressive Party (PP). In exchange, each technical made political appointee helped their backing parties (and political bosses) by extracting bribes from contractors and channeling resources to their patrons in the form of official and off-the-book campaign donations. In the operation, they also enriched themselves by keeping a share of the bribes. Promotion inside Petrobras, thus, started to require both technical ability and lack of moral standards.

For instance, Paulo Roberto Costa, who was the director for downstream between 2004 and 2012, entered Petrobras in 1977 after graduating in mechanical engineering. He had worked for years in the company's most important production assets, slowly rising within the company. In order to become a director, a position with power and perks similar to those of oil majors, he sought a political patron.

⁸⁷ For chronicles of the operation see Netto (2016) and Paduan (2016).

José Janene, a federal deputy and leader of the PP, backed his name in exchange for access to Petrobras' suppliers and bribes. According to Costa's plea bargain testimony, he usually collected a 3% bribe for contracts in the downstream.⁸⁸ Two-thirds of the amount went to the PT – the ruling party. From the other 1%, 60% of it was directed to the PP, 20% was split between himself and Alberto Yousseff, and the remainder covered the costs of money laundering. As his directorate became more important with increased investments (and bribing opportunities), Costa felt that his position was under menace by other parties that pressured the executive to appoint a new director. He then started to broaden his political support, collecting bribes for others parties as well, such as PMDB. Similar to Costa, other directors such as Renato Duque, Nestor Cerveró, and Jorge Zelada, all jailed in the course of the investigation, were longtime employees of Petrobras who became directors due to party links (Paduan 2016). For external observers, the company continued to be run by professional career employees.

One exception to this rule was Sérgio Machado, a politician who occupied from 2003 to 2014 the presidency of a subsidiary of Petrobras, Transpetro. A former senator with no experience in the oil sector, Machado was appointed to the position by the PMDB. In his statement to prosecutors, he was blunt about how he saw his mission as CEO of Transpetro. He claimed to follow two guidelines: extract the maximum possible efficiency of Petrobras' contractors, both in quality and price, and extract the maximum amount of bribes to pass on to politicians who ensured his political appointment.⁸⁹ He was in charge of an ambitious industrial policy program to support the creation of new shipyards through a government procurement policy of renewing the fleet of oil tankers of Petrobras, with a minimum local content of 65% (Petrobras 2013).

As soon as the magnitude of the scandal became clear, in 2014, it raised an immediate problem for the company and its auditing firm, PwC: Petrobras' book value was not reliable. Due to the confessions of executives who entered plea bargains that the price tag of large investment projects included the payment of bribes, the balance sheet of Petrobras counted as the value of productive assets what really was the cost of corruption. PwC refused in late October of 2014 to sign the company's third-quarter results until the cost of corruption was written-off. The team of Petrobras and hired lawyers worked for months to release an estimate of the total cost of corruption. It ultimately took into account the testimonials and data collected from the plea bargains made during the "Carwash" Operation and deduced from 1% to 3% the value of projects cited in the corruption scandals. Petrobras

⁸⁸ Collaboration statement n. 26 by Paulo Roberto Costa (09/02/2014).

⁸⁹ Collaboration statement n. 1 by Sérgio Machado (05/04/2016).

also performed an impairment test, which compares the book value of projects with their fair value. On April 22, 2015 the company was finally able to publish audited financial results. It registered a significant impairment charge and a write-down of improperly capitalized additional spending (bribes). The result was a loss of R\$21 billion (US\$7.2 billion) in the 2014 financial statement, the first negative result of Petrobras since 1991 (Petrobras 2015).

Based on the company's financial statements, data on campaign donations, and documents disclosed by the Carwash operation, this study investigates the politicization of Petrobras' procurement practices, the sources of losses of the company, and how those losses varied within industry sector. While corruption existed before in Petrobras⁹⁰, the evidence points to 2004 as the beginning of a systematic usage of the company to serve Brazil's coalitional presidentialism. Consequently, it was after Petrobras had mastered production from deep offshore oil and output levels were rising consistently, putting the country on the verge of oil self-sufficiency (what Petrobras celebrated in 2006). First, I analyze the political activity of Petrobras' suppliers regarding campaign donations vis-à-vis other firms in the country. This step is necessary in order to ascertain if firms operating for Petrobras developed distinctive political preferences, as measured by their party preferences when donating money. Then, I address the within-sector variation, studying losses in the upstream and downstream operations. The theoretical expectation is that rent-seeking will be higher in the downstream, which has stronger distributive pressures in the form of price subsidies and localization of investments. On the other hand, the upstream is the only segment directly affected by an industrial policy of LC requirement which partly protects the Brazilian industry from free imports and it is conceivable that such political protection could lead to higher bribes. The analysis that follows is divided into four topics: a) official political activity by suppliers; b) direct cost of bribes; c) politically motivated investment decisions; and d) domestic pricing (subsidies) of oil products, such as gasoline.

3.2. Measuring political activity by suppliers

Brazil's open list proportional representation electoral system makes elections particularly costly. Candidates have to campaign over large electoral districts and incentives for party fragmentation

⁹⁰ In his statement to prosecutors and in a Congressional Inquiry, the former senior executive Pedro Barusco mentioned that he received his first bribe in 1997 from a representative of the Dutch company SBM, as a personal gift. However, only by 2004 kickbacks became an institutionalized practice to be shared with parties. See also Paduan (2016).

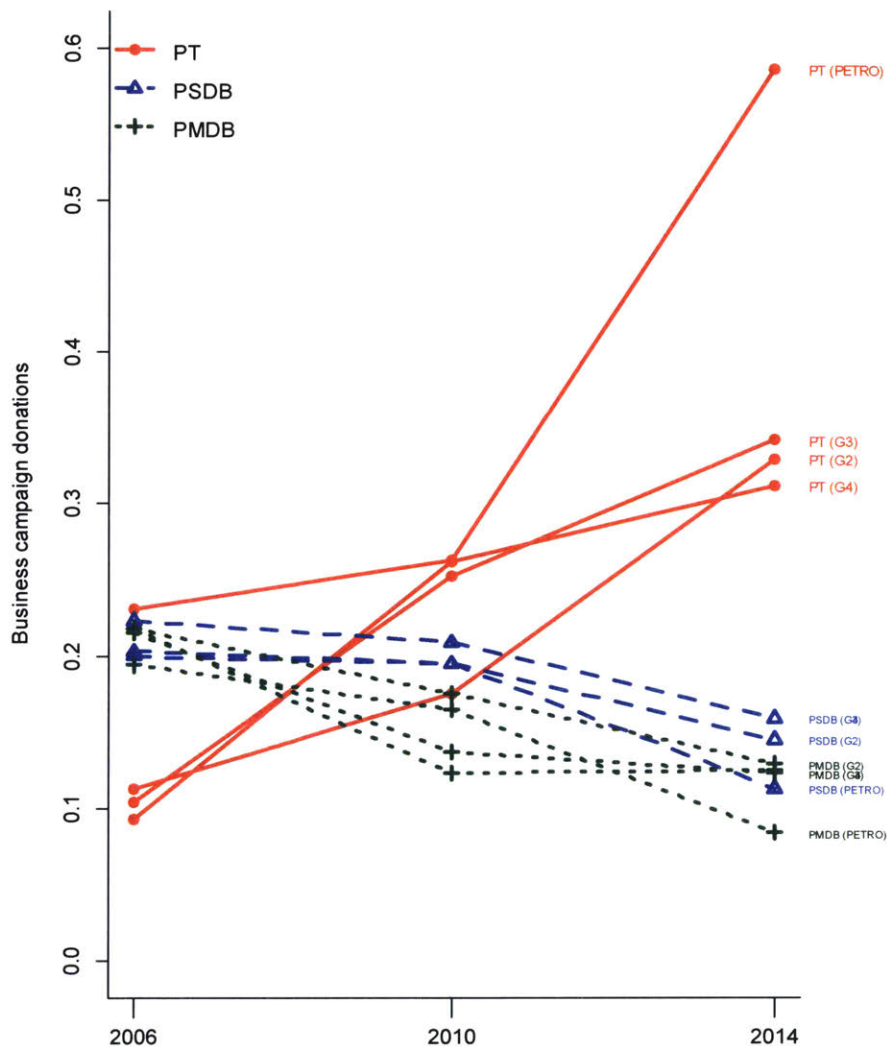
are high, leading to weak party structures. For these reasons, access to financial resources is critical to electoral success (Sacchet and Speck 2012, Samuels 2001) and there is also evidence that campaign donations can buy policy outcomes in Brazil (Boas et al. 2014). Taking into account Petrobras' investment growth (Figure 5.2) and the government's critical role in determining the company's strategy and procurement priority, it is expected that suppliers to the firm would be sought for campaign donations.

To investigate how donations differed between suppliers and other groups of firms, I matched data on campaign donations with Petrobras' suppliers and federal government contractors. The group of suppliers of Petrobras was obtained from the company's transparency portal and is made of 5067 distinct companies, which had contracts of R\$1 million or more between 2005 and 2015. From Brazil's Superior Electoral Tribunal (TSE) I obtained campaign donations data for the general elections of 2006, 2010, and 2014.⁹¹ In total, close to 50,000 different firms donated money in the three different elections, with an average of 18,500 unique firms per election. Firms' unique tax-identification numbers (CNPJ) were then used to query the Federal Government Open Data Database (<http://dados.gov.br/>), allowing the identification of which donor firms also had supply contracts with the federal government, such as different ministries and agencies. Each year, about 4,700 firms had active contracts with the federal government, or a quarter of them, but only about 900 were Petrobras' suppliers (or 5% of the average total donors per year).

Results are summarized below in Figure 5.3 for the three main parties of the country (PT, PMDB, and the oppositionist Brazilian Social Democracy Party, PSDB) across four different groups. For comparison purposes, the groups of firms are divided between (a) donations by Petrobras' suppliers (PETRO); (b) donations by all firms except Petrobras suppliers (G2); (c) donations by federal contractors (G3); and donations by federal contractors with the exception of firms that were also suppliers to Petrobras (G4). While the preference to donate to PT grows across all groups from 2006 to 2014, it is indeed much higher for the group of Petrobras' suppliers: it reaches a peak of 58.6% of total donations within this group, while donations for PSDB and PMDB go down to 11.3% and 8.4%, respectively. In contrast, 26.6% of the donations made by federal contractors (not including Petrobras' suppliers) went to PT, with PSDB receiving 13.6% and PMDB 10%. As for the weight of Petrobras' suppliers in the total

⁹¹ Given that Petrobras' does not make available the list of contractors before 2005, it is not possible to examine campaign donations activity for 2002, when PT was not in control of the presidency. The year 2006 still makes a good baseline measure because it is before the discovery of the pre-salt and the ramp-up of investments in Petrobras in both upstream and downstream activities.

amount of campaign donations made by firms, it increased from 5.6% (R\$35 million) in 2006 to 8.2% (R\$92 million) in 2010. In 2014, when the scandal was already known, it stayed practically the same: 8.1% (R\$105 million), but the PT preference reached its peak.



Source: Author's calculation based on data from TSE, Petrobras, and Federal Government

Figure 5.3: Campaign donations activity

This data highlights the increased links between contractors and the main party of the ruling coalition. The results are in line with previous studies of campaign donations in Brazil and PT's dominance within public contractors (Boas et al. 2014). The pattern uncovered here is also supported by statements made by collaborators in plea bargains, where it has been informed that part of the bribes

were paid as official campaign donations and that PT received the lion's share of the division. It, however, does not allow for distinguishing suppliers in the downstream from the upstream, but other sources of evidence allow for estimating the variation of bribes and losses across industry segments.

3.3. Direct costs of bribes

In studies about corruption it is rarely the case that a researcher has access to direct evidence and is able to compare the cost of corruption and factors that influence the level of corrupt behavior (McMillan and Zoido 2004, Olken and Pande 2012, Treisman 2007). In the case of Petrobras, it is possible to compare which projects paid the highest amount of bribes and what were the mechanisms of payment and negotiations between corrupt executives, politicians and contractors.

Data for this subsection comes from the previously confidential statement of former Petrobras' senior executive Pedro Barusco. Among the documents that he gave to the Federal Police and public prosecutors was a spreadsheet with 88 large projects under his supervision, with detailed information on the project type, date, the total amount, the bribe rate, the companies involved, and how the bribe was to be split. Barusco's division was responsible for the bulk of large projects of Petrobras, although some projects were directly contracted by other divisions, such as the International, Gas and Energy and Downstream directorates. Therefore, although this spreadsheet does not cover all the corruption found in Petrobras, it covers a large part of it. This evidence is supplemented by Barusco's own statement to congressional committees (*CPI da Petrobras* and *CPI dos Fundos de Pensão*), statements made by others collaborators who entered in leniency agreements, petitions made by public prosecutors and judicial decisions.

The data is particularly useful to test whether the industrial policy decision to procure parts of the capital goods locally resulted in more bribes. The LC policy creates incentives to the development of Brazilian-based industries by protecting domestic markets against free imports of goods, like drilling rigs, oil platforms and subsea equipment. It typically imposes quantitative targets to be met by oil operators in the upstream, like a requirement that 55% of an oil platform be built using goods produced domestically, as is the case in Brazil. Oil operators that cannot comply can petition for waivers when the domestic market is unable to meet the demand or pay fines if they opt to not fulfill the requirement. The LC policy establishes a global goal but allows the oil operators some room to maneuver to manage the achievement of the target or to escape the policy requirements under certain conditions.

Thirty-five companies are listed in the dataset⁹², of which eight are international or local subsidiaries from a variety of countries.⁹³ The spreadsheet has a variety of projects from 2003 to 2010, including: parts of two new refineries and upgrades of existing ones, gas pipelines, local headquarters, expansion of Petrobras' R&D center, oil platforms. The last group of item is the only one directly affected by LC, while all others have no binding mandate to fulfil a specific target of domestic purchase. It is possible, therefore, to compare the bribe rate of products where Petrobras had the incentive to procure domestically due to LC versus others, which the company freely contracted. Barusco's accounting lists only projects where the bribe rate ranged from 1% to 2%, while in the statement made by the former director of downstream, Paulo Roberto Costa, bribes were as high as 3%.⁹⁴ If anything, the difference between the downstream and upstream segment will be understated, since the projects handled by the downstream director had a higher bribe rate. In contrast, oil platforms and drilling rigs, LC requirements, pertain to the upstream segment.

Another difference between contracts from the LC requirement and other activities of Petrobras is that platforms, drilling rigs and their components are priced in dollar. These are tradable goods, with international price and suppliers, while domestic construction services hired by Petrobras are priced in Brazilian reais (BRL). Although they can have imported components, construction services are purchased domestically and paid in BRL. On the other hand, capital goods for the offshore oil industry follow closely international maritime and safety standards and can be exported, as they currently are.⁹⁵ These goods are mobile, standardized, and provided by a competitive international market where price differences can easily be spotted.

In contrast, construction services, especially in complex projects, have more room for customization. Specific terrain challenges, availability of local infrastructure and climatic events contribute towards losses during construction that can be contingent and variable. These characteristics

⁹² Alusa, Andrade Barbosa Melo, Gutierrez, Bueno, Camargo Corrêa, Carioca, CNEC, Contreras, Construbase, Construcap, EAS, EBE, EIT, Engeform, Engevix, Floatec, Galvão, GDK, Keppel Fels, Mendes Jr., MPE, OAS, Odebrecht, Odebei, Promon, Queiroz Galvão, Quip, SBM, Schain, Setal, Skanska, Techint, Tomé, Toyo Setal, UTC.

⁹³ Argentina (Contreras), Sweden (Skanska), Japan (Toyo), Singapore (Keppel Fels), United States (Quip), Netherlands (SBM), Italy (Techint), Germany (Hotchief). CNEC was originally a Brazilian company but was acquired in 2010 by the Australian group WorleyParsons. CNEC appears in Barusco's spreadsheet in a 2009 contract in consortium with Camargo Correa, thus one year before it was acquired.

⁹⁴ The additional one percentage point on bribes from Costa's directorate was used to channel resources to himself and the parties that backed his appointment (PMDB and PP). The lion's share of corruption in Petrobras was within the engineering directorate, which had bribes split between PT and the employees appointed by PT leaders.

⁹⁵ Oil tankers and platforms built in Brazil are formally exported out of the country and then imported as part of a tax break regime called *Repetro* that was created in 1999.

of being unique goods facilitates over-invoicing and overpayment because it is more difficult to detect bribes (Shleifer & Vishny 1993). Accordingly, in political economy models of bribe extraction, bureaucrats are assumed to choose an optimal bribe rate taking into account market forces and the probability of being caught (Olken and Pande 2012, Shleifer & Vishny 1993). These factors would lead us to expect that bribes in the tradable goods (predominantly in the upstream) would be lower than in other segments of Petrobras, such as building new refineries. To test this hypothesis, I regressed the data of bribe rate on the type of contract, which is a dummy for tradable goods. Figure 5.4 presents the difference of means of the variation on bribe rate with confidence intervals:

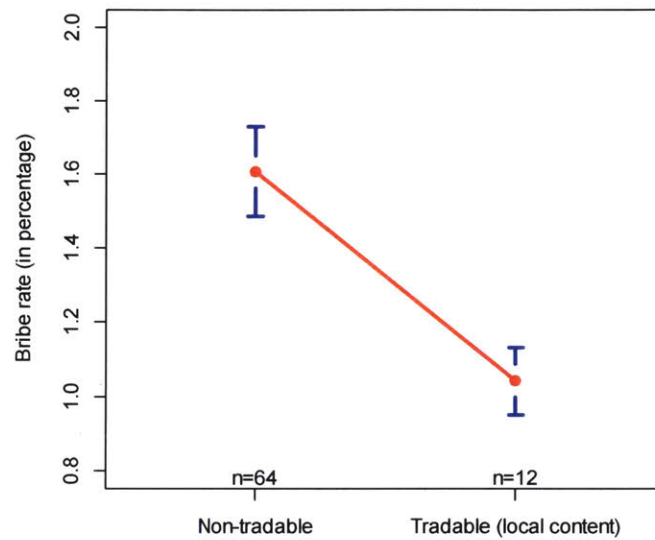


Figure 5.4: Variation on bribe rate

Full regression results are displayed in Table 5.2, where I also control for the value of the contract.⁹⁶

⁹⁶ Contracts priced in dollars were converted to Brazilian Reais (BRL) using the currency exchange rate of the day the contract was signed. In the list, R\$ 48 billion of projects are priced in BRL and US\$ 10.7 billion in dollars.

Table 5.2: Variation on bribe rate

	Model 1	Model 2	Model 3
Intercept	1.60***	1.55***	1.43***
	-0.061	-0.077	-0.087
Tradable/LCP	-0.567***	-0.71***	-0.41***
	-0.073	-0.07	-0.092
Contract value (in 100 million BRL)		0.11	0.304***
		-0.065	-0.07
Tradable/LCP*Contract value			-0.29*
			-0.07
Adj. r-squared	0.16	0.2	0.25

Robust standard errors in parentheses

As is possible to see, results are statistically and substantively significant and in line with the theoretical expectations.⁹⁷ Tradable goods, that operate in a more competitive market even when benefitting from an LC policy, paid less in bribes than other contracts made by Petrobras. Model 2 shows that contract value is significant at the 10% level ($t = 1.77$). Once an interactive term is added, as is done in Model 3, contract value is also significant at the 1% level ($t = 4.34$). For a contract of R\$100 million, the predicted bribe rate from Model 3 is of 1.73% for non-tradable goods ($1.43 + 0.304 = 1.734$) and 1% for goods purchased under LC rules ($1.43 - 0.41 + 0.304 - 0.29 = 1.034$). Given the interaction effect, higher contract values show the bribe rate of non-tradable goods increasing faster than goods purchased under LC. This suggests that there are more rents to be shared with politicians and Petrobras executives outside of the upstream segment, despite its LC policy.

Statements made by Pedro Barusco to the Federal Police and to the congressional inquiries that investigated the Petrobras scandal corroborate such interpretation. The data presented above refers to contracts made directly by Petrobras, but the state company helped to set up a new company specifically to purchase new drilling rigs to exploit the pre-salt area, Sete Brasil, formed in 2010. Barusco was one of the first executives of Sete Brasil after retiring from Petrobras. According to him, he had tough negotiations with national shipyards in order to bring prices to international standards. Sete Brasil was designed to be a portfolio manager of O&G assets and signed contracts to lease 28 drilling rigs to

⁹⁷ From the 88 fields, there is missing data on bribe rate for 12 projects – only one related to the upstream segment and quoted in dollars, a contract with the Dutch SBM.

Petrobras, with the commitment of purchasing them in Brazil, following the LC policy. Sete Brasil's total investment was projected to be US\$25.7 billion. According to Barusco, bribe rates in the Sete Brasil contracts were reduced to less than 1% in some cases in order to bring prices closer to Asian producers and due to pressures coming from Petrobras.⁹⁸

Similarly, Sérgio Machado, who was the CEO of the subsidiary Transpetro, revealed to prosecutors that he used to charge 1% of bribes for goods (such as oil tankers) but 3% for services.⁹⁹ In many cases, shipyards that were built following the LC industrial policy actually delayed payments of bribes as they were suffering operational losses. For instance, the EAS shipyard was built only after winning an order from Transpetro to deliver ten "Suezmax" ships. However, due to productivity problems, the first Suezmax was delayed by 623 days and this resulted in contractual fines to the firm. According to Machado's plea bargain, the owners of the shipyard, the business groups Queiroz Galvão and Camargo Corrêa, pressured for contract renegotiations so Petrobras could absorb the losses. In exchange, the business groups offered more bribes. The request was denied and shareholders of EAS had to bear the losses, which already summed to over a \$1 billion in the shipyard's operation (Lima-de-Oliveira 2016).

The evidence so far suggests that the upstream, even with an LC policy, was not associated with higher bribe rates. The corrupt behavior actually matches political economy models that predict optimal bribe rate subject to market constraints and monitoring capabilities – and LC upstream contracts are subject to forces that likely constrain rent-seeking. First, goods are priced in the international market, so price monitoring is easier, and large disparities are more likely to trigger suspicions from auditing agencies, shareholders, and the employees of the company who are not part of the scheme. Second, local suppliers are still in their learning curve trying to match more competitive producers, so their lower efficiency means that there are less rents to be shared¹⁰⁰. Finally, the LC applies to all oil companies operating in E&P in Brazil, including international majors like Chevron, Shell and Statoil. Some companies operate their own production platforms while others have partnerships with Petrobras in developing specific fields and sit in the board of investment decisions, including in the highly productive

⁹⁸ This is detailed in his "Collaboration Agreement" dated 11/20/2014 with the police and public prosecutors, originally confidential, and his public statements made on 03/10/2015 to the *CPI da Petrobras* and on 11/19/2015 to the *CPI Fundos de Pensão*.

⁹⁹ Collaboration Agreement of José Sérgio de Oliveira Machado No. 2, dated 05/04/2016.

¹⁰⁰ Another evidence of this mechanism is that the only bribe rate for oil platforms above 1% in the Barusco dataset comes from the Keppel Fels shipyard, from Singapore, which opened a manufacturing plant in Brazil, bringing their own expertise in this business. All other shipyards are owned by Brazilian companies.

fields of the pre-salt area. Therefore, investments in the upstream are commonly made together with other partners, making it harder to conceal bribes, or are made directly by firms other than Petrobras. On the other hand, Petrobras' monopoly in the downstream in Brazil meant that investment decisions were made solely by the company, a practice that facilitated over-invoicing and political influence.

3.4. Political use of Petrobras' investments

"...there is nothing like a period of high prices to make the worst investment decisions ever."

Leonardo Maugeri, *The Age of Oil* (2006, p. 142)

Starting with Luiz Inácio Lula da Silva's tenure in 2003, Petrobras was used as a tool to pursue industrial policy and regional politics, such as allocating investments of refineries and petrochemicals in states governed by political allies. This was not concealed – in several speeches and interviews President Lula da Silva and the then minister of Mines and Energy, Dilma Rousseff, praised Petrobras for decentralizing and boosting its investment.¹⁰¹ Furthermore, Petrobras' successful track record of discoveries opened up the possibility of becoming a net exporter in the medium-run, which had the double effect of spurring optimism concerning new investments and opening more financing opportunities. A major example was Petrobras' commitment to construct four new refineries at the same time – all in states governed by political allies (Rio de Janeiro, Pernambuco, Ceará and Maranhão). This would add an additional capacity of 1.3 million bpd in a few years – more than half of the refining capacity of 2013 of 2.124 million bpd spread in a park of 12 refineries that took decades to build (Petrobras 2013).

Unsurprisingly, these projects were rushed to fit political deadlines and served as stage for ribbon-cutting ceremonies followed by political speeches. Actual execution, however, suffered from project deficiencies and cost overruns. A major example is the Abreu e Lima refinery, in the state of Pernambuco. It was launched in 2005 as a joint-venture with the Venezuelan PDVSA with an original budget of \$2.5 billion. As a symbol of regional integration and proximity with the administration of Hugo

¹⁰¹ Lula da Silva even claimed that the government pressured Petrobras to invest in refineries as part of the government's countercyclical investments after 2008, over objections of the company's executives (*Valor* 09-17-2009).

Chávez, then president of Venezuela, the Abreu e Lima refinery would be constructed by Petrobras but jointly run and designed to process half of Brazilian oil and half of Venezuelan extra heavy crude oil. This required a more complex engineering due to the distinct characteristics of the two sources of oil and the solution was to construct two processing units in the same site, each customized to one type of oil.

In 2006, the planned capacity of the unit was increased from 150,000 bpd to 230,000, with a new budget set at \$4 billion. In the following year, Petrobras approved an acceleration plan to speed up the construction of the unit and have it partially concluded by August 2010 – just two months before general elections and Rousseff’s first presidential bid. Acceleration implied relaxing some constraints and best practices, such as bidding for services and equipment only when a detailed engineering project is concluded. Contracting without a final engineering project can lead to renegotiations due to scope changes, increasing the room for corruption or plain inefficiencies.

Budget estimates of the unit kept rising and PDVSA, which suffered from its own cash and management problems, ended up never investing in the project. This led Petrobras to undertake the project alone and discard all the engineering work designed to process the Venezuelan oil. The refinery was only inaugurated in December of 2014, at the height of the corruption investigations and without any public ceremony. The cost reached \$18.5 billion, and with only half of the operational capacity (Petrobras 2015). The board of the company recognized that the unit will never be profitable – in fact, the lifetime return on investment is \$3.2 billion negative.¹⁰²

The Abreu e Lima project is emblematic of political meddling. First, the company was used to serve a foreign relations priority which was establishing close ties between Venezuela and Brazil, as desired by presidents Lula da Silva and Hugo Chávez. Second, the project was accelerated to coincide with the electoral period, compromising the internal rules of compliance and best practices. Unfortunately, the Abreu e Lima project was hardly alone in these respects. Even higher losses were registered for the Comperj refinery project in Rio de Janeiro. In Maranhão and Ceará, where two refineries were announced in 2010, Petrobras spent millions in political events and in preparing the infrastructure of the host sites until it was forced to cancel the projects in the third quarter of 2014, with write-downs of R\$2.8 billion in its assets.

Losses in refineries accounted for most of the impairment impact in the total assets of Petrobras, recognized in the 2014 audited financial statements. Total losses were of R\$44.6 billion, with

¹⁰² See “Refinaria Abreu e Lima dará prejuízo de US\$3,2 bi,” Folha de São Paulo, 01/18/2015.

refineries responsible for R\$31 billion (~70%) and the rest spread into petrochemicals and exploration and production projects in Brazil and in the US Gulf of Mexico (Petrobras 2015). Thus, the R\$31 billion (roughly \$10 billion) can be attributed to mismanagement and inefficiencies, in good part motivated by political factors. Another source of loss in the downstream originated from a growing price gap between the domestic gasoline price and the international price, analyzed next.

3.5. Price subsidies

While Brazil has found immense new oil reserves since the mid-2000s in the pre-salt oil province, development of the technically challenging ultra-deep reservoirs takes time to reach production stage – up to ten years from the exploratory phase. Geological abundance is known to exist, but actual output had been below the country's consumption needs – making Brazil still a net importer of oil throughout the period under analysis, but on the verge of being a net oil exporter.

Traditionally, domestic prices of oil products (gasoline, diesel, etc.) were determined directly by the federal government, which at times preferred to subsidize prices in order to sustain industrial output or please voters. A mechanism called “oil-account” preserved the cash flow of Petrobras by registering the cost of the subsidy in an account that had to be paid by the government using budget resources. In 2002, marking the last stage of the market opening reforms initiated in 1995, the prerogative of having the federal government directly setting prices of oil products was abolished and the “oil-account” eliminated. Going forward, prices would be set by the board of Petrobras following international prices, with some lags to insulate the domestic market from international volatility, thus converging in the medium-run. Private companies were free to open refineries or import oil products and sell it directly. However, Petrobras kept a monopoly position in the refinery park and all the port infrastructure to unload imports. Additionally, it never adopted a hard rule in determining price adjustment – the timing of price changes had been arbitrarily determined by the board of the company. A monopoly position coupled with uncertainty in its price strategy created a substantive barrier of entry to potential competitors – and no other company decided to invest domestically in building new refineries nor setting consistent import operations.

Figure 5.5 plots a time-series of the price of gasoline in the US, the market that most closely reflects international fluctuations, with the price practiced in Brazil.¹⁰³ From the beginning of the series in 2001 up to the end of 2008 there is a strong correlation between the two prices: 0.93. Changes in domestic prices of gasoline in Brazil are a product of two main variables: price adjustments by Petrobras and exchange variations. Despite that, there is a clear trend of convergence between the domestic and international price, although occasional differences are sometimes substantive. Beginning in 2008 there is a decoupling of prices. After the 2008 financial crisis, commodity prices dropped drastically but consumers in the Brazilian market were forced to pay higher prices for 40 consecutive months, from November of 2008 to February 2012. Starting in the following month and ending only 39 months later, in November of 2014, domestic prices were below international markets. An adjustment only came on November 6, weeks after the second-round that reelected president Dilma Rousseff (PT) by just 3.4 p.p. of difference to Aécio Neves (PSDB), one of the tightest margins in Brazil's electoral history. Throughout Rousseff's administration from January 2010 to the end of 2015, price correlation fell to just 0.58 and tended to be below the US market price.

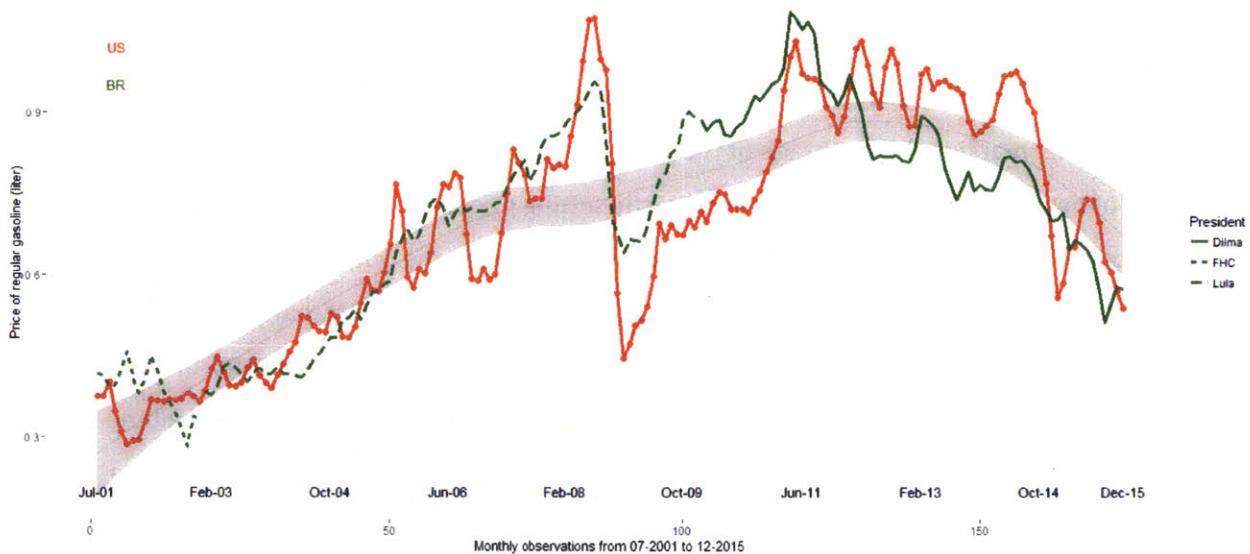


Figure 5.5: Price difference of gasoline in BR and in the US

¹⁰³ Monthly domestic prices of retail gasoline in Brazil are from the Oil Regulatory Agency (ANP) and were converted to dollars. US data are from the Energy Information Agency (EIA) and were converted from gallons to liters. The comparison is intended to highlight convergence or divergence of trends, as the retail gasoline in Brazil is different from the US with respect to formulation. Brazil has a mandatory blend with ethanol of up to 27%, but also has the cheapest cost of production of ethanol in the world, at times cheaper than gasoline. Taxes on fuels in Brazil are higher than in the US and were removed for comparison purposes.

Both periods – of price over- and undervaluation – received intense coverage by the press and were widely known by market analysts and minority shareholders. Obviously, complaints from shareholders focused on the latter effects. One asset management company estimated total losses of R\$72 billion or about \$32 billion at the time the complaint was registered.¹⁰⁴

In the course of a congressional investigation (*CPI da Petrobras*) the company was obliged to send confidential documents to lawmakers, including minutes and the audio of board meetings. These materials were leaked to the press and revealed stark divisions between Petrobras employees, representatives of minority investors and board members appointed by the federal government. The leaked information disclosed Petrobras' own calculations of the losses due to price subsidies: R\$80 billion (\$35 billion)(Gaspar 2015). Sales of fuels account for half of Petrobras' revenues and the company was losing money each time a consumer purchased gasoline or diesel during most of Dilma Rousseff's government. This is clearly shown in Table 5.3 that displays net profits of the two main segments of the oil company: the upstream and downstream:

Table 5.3: Net profit per business segment (in million of R\$)

Year	Upstream	Downstream
2003	\$558	\$599
2004	\$15,796	\$2,263
2005	\$22,836	\$5,545
2006	\$24,763	\$6,109
2007	\$26,829	\$5,908
2008	\$37,615	\$3,608
2009	\$19,599	\$13,332
2010	\$29,691	\$3,722
2011	\$40,575	-\$9,970
2012	\$45,452	-\$22,931
2013	\$42,266	-\$17,752
2014	\$32,008	-\$39,836
2015	-\$12,963	\$18,034

Source: Petrobras' financial statements

¹⁰⁴ Antares Capital Management, a minority investor in Petrobras, complained formally twice to the Securities Commission of Brazil (CVM) against the practice (Fuzzetti 2013). Petrobras defended the practice by claiming that it sought price convergence in the long run and was spared by the market regulatory agency and by the board of the stock exchange of any penalty.

While the upstream was mostly in a positive rising trend, the downstream shows a fourfold increase in net profits in 2009, when it was charging higher than the international prices. A series of losses start after 2011, reaching a peak in the electoral year of 2014. Finally, in 2015 the upstream segment suffered losses from impairment charges due to the fall of oil prices (which reduced the project revenues from Petrobras' high-cost deepwater fields), while the downstream regained profitability. To finance these losses, Petrobras was burning cash reserves and increasing its total debt. State-owned federal banks provided a soft-budget constraint to Petrobras by increasing their funding to the company especially during the financial crisis of 2008-09, when the international banking system refrained from financing larger investments. As can be seen in Table 5.4, Petrobras' total debt rapidly increased, reaching R\$492 billion in 2015, equivalent to \$127 billion.

Table 5.4: Petrobras' debt burden (in millions of R\$)

Year	Total gross debt	Debt with public banks	%
2003	\$60,498	\$4,400	7.27%
2004	\$52,756	\$1,800	3.41%
2005	\$48,242	\$5,300	10.99%
2006	\$46,605	\$8,100	17.38%
2007	\$39,741	\$7,300	18.37%
2008	\$64,713	\$19,400	29.98%
2009	\$102,450	\$46,100	45.00%
2010	\$117,915	\$51,400	43.59%
2011	\$155,554	\$32,400	20.83%
2012	\$196,314	\$65,100	33.16%
2013	\$267,820	\$69,800	26.06%
2014	\$351,035	\$75,100	23.51%
2015	\$492,849	\$95,034	19.28%

Sources: Petrobras financial statements and author's calculations

Debt financing was facilitated by the impressive investment program that the company was pursuing, mostly focused on developing the pre-salt reservoirs and building new refineries. Especially from 2009 onwards, the federal government used Petrobras as an instrument for Keynesian counter-cyclical investment, boosting the domestic demand when the world was passing through tough economic times and limiting price adjustment to ease inflationary pressures. When state and federal taxes are added, Brazilian consumers do not necessarily pay lower gasoline prices in comparison to the international market. In fact, for most of its history, Brazilians paid higher domestic prices in oil products

as a cross-subsidy to finance Petrobras' exploratory campaign, particularly during the military regime (Randall 1993). However, after the discovery of the pre-salt oil area and the perspectives of future abundance, the company's cash became a honey pot for energy subsidies, which ended up representing the largest total loss of the politicization of the company.

4. Conclusion

Petrobras has been both a source of pride for Brazilians, given its technological prowess and leadership in deep offshore oil, and of shame, after a police operation revealed that the oil company was the center of a corruption scandal that involved contractors, senior managers and political parties (Paduan 2016). Brazil's oil company proved to be both innovative and highly capable of developing complex offshore projects and very corrupt – an unlikely combination for NOCs. Such heterogeneous outcome defy predictions derived from the rent-seeking and the resource-curse/National Oil Companies literatures. The first tends to see rent-seeking associated with low innovation activity (Acemoglu and Robinson 2012, Murphy et al. 1993, Tullock 1990) and the second has cited Petrobras, and its operating institutional environment, as role models (Bridgman 2008, Luong and Weinthal 2010, Oliveira 2012, Thurber et al. 2011, Victor 2013).

How to account for these puzzling facts? The answer lies in recognizing that what changed in Brazil were not broad level institutions that could constrain rent-seeking from its oil company, but rather the access to oil rents from Brazil's challenging geology. Kolstad and Wiig claim that "The resource curse is not about resource abundance per se, it is resource rents" (2009, p. 5324). What makes Petrobras and the *Petrobrão* scandal stand out as a case in the resource curse literature is that Brazil's resources rents are a result of creation, not simply capture. In the process of creating reserves, through technology, Petrobras led the domestic demand for capital goods and technological solutions. This generated positive spillovers to the economy, an outcome that Kolstad and Wiig (2009) recognize that can happen for cases of resource-rents that require considerable technological development – Norway in contrast to Saudi Arabia, in their example. However, predation followed abundance, as oil-poor Petrobras had been traditionally spared from political interference in its management decisions and was seen as a "pocket of efficiency" in the Brazilian state (Oliveira 2012, Evans 1995), a situation that changed when it became oil-rich.

As argued in the previous chapter, innovation was key to create rents given Brazil's complex deep offshore oil resources. Innovation was thus supported through public sources of funds (oil rents earmarked to R&D in universities) and the company's internal resources, even at the height of the large corruption scheme that started in 2004. The management of the company continued in the hands of career technical employees, but this time they were coopted to serve a corruption scheme involving contractors, politicians and parties. In short, the scheme worked through the active participation of the firm's senior management in paying overcharged contracts in order to receive kickbacks that ranged from 1% to 3%, to be shared with parties of the ruling coalition. However, losses of the company went beyond the direct cost of bribes. As Petrobras reached successive records of production and discoveries, it became increasingly a target for politicians interested in extracting bribes and in using it as a tool for distributive policies, which included industrial policies, regional development and subsidized gasoline prices. It became, as shown in Figure 5.1 on presidential speeches and the data from campaign donations (Figure 5.3), a key company in Brazil's politics.

The empirical evidence shows that bribe rates and financial losses varied widely between the industry segments of upstream (oil exploration and extraction) and downstream (refining and petrochemicals). Using as data sources a spreadsheet of bribe rates of 88 large projects signed between 2003-2010, testimonies made in plea bargains, and financial records of Petrobras, this study shows that the upstream had lower bribe rates and generated more consistent positive economic results to the company than the downstream, in line with the theoretical expectations. Significantly, an industrial policy like local content in the upstream was not shown to be associated with higher bribe rates and even suppliers which paid bribes lost orders from Petrobras when failed to meet deadlines. These facts underline the role of productive challenges that can constrain rent-seeking in local content policies in O&G. The findings also highlight the importance of disaggregating activities by segment in order to judge the effects of distributive pressures and industrial policies in the oil industry.

Finally, the evidence suggests that Petrobras can continue to be an innovative company and spared from party corruption, as had been before, if internal promotions and investment goals are shielded from political influence. The fact that the Carwash operation uncovered corruption in Petrobras, and in Brazilian politics more generally, before the country started to be an important oil exporter can may turn out to be a blessing in disguise. The demonstration effect of having a number of former employees, politicians and contractors in jail may prevent future political rapaciousness when

rents become much more plentiful when the extraction of the pre-salt increases in volume, as expected in the years to come.

Appendix

Table A5.1: Campaign donations by different groups (2006)

Party	All firms (non Petrobras)		Petrobras' suppliers		Federal contractors		Federal contractors (non Petrobras)	
	Total per party	Share	Total per party	Share	Total per party	Share	Total per party	Share
PAN	\$824,529.97	0.14%	\$8,500.00	0.02%	\$197,274.10	0.17%	\$197,274.10	0.20%
PC do B	\$5,249,411.08	0.87%	\$503,694.69	1.40%	\$1,421,594.29	1.22%	\$1,362,394.29	1.36%
PDT	\$29,064,294.53	4.80%	\$864,800.00	2.40%	\$5,180,298.34	4.45%	\$4,828,498.34	4.82%
PFL	\$77,919,069.07	12.88%	\$4,423,564.85	12.30%	\$15,127,369.40	13.01%	\$12,653,299.40	12.64%
PHS	\$984,835.34	0.16%	\$15,300.00	0.04%	\$90,291.28	0.08%	\$90,291.28	0.09%
PL	\$16,997,355.55	2.81%	\$958,598.00	2.67%	\$3,448,047.20	2.96%	\$2,930,547.20	2.93%
PMDB	\$131,864,157.56	21.79%	\$6,981,911.86	19.41%	\$25,012,550.07	21.50%	\$21,815,838.21	21.79%
PMN	\$3,600,236.20	0.60%	\$167,400.00	0.47%	\$408,650.29	0.35%	\$377,250.29	0.38%
PP	\$36,396,369.87	6.02%	\$1,823,000.00	5.07%	\$7,874,628.80	6.77%	\$6,474,628.80	6.47%
PPS	\$32,750,358.59	5.41%	\$1,298,335.00	3.61%	\$6,897,764.47	5.93%	\$6,196,479.47	6.19%
PRONA	\$1,272,832.24	0.21%	\$200,000.00	0.56%	\$229,660.00	0.20%	\$229,660.00	0.23%
PRP	\$982,652.94	0.16%	\$98,000.00	0.27%	\$92,926.00	0.08%	\$91,926.00	0.09%
PRTB	\$888,416.84	0.15%	\$15,000.00	0.04%	\$201,039.22	0.17%	\$201,039.22	0.20%
PSB	\$23,517,537.95	3.89%	\$1,015,575.30	2.82%	\$4,012,970.04	3.45%	\$3,566,630.04	3.56%
PSC	\$4,862,318.01	0.80%	\$293,600.00	0.82%	\$849,197.87	0.73%	\$700,197.87	0.70%
PSDB	\$123,045,146.36	20.34%	\$7,198,432.69	20.01%	\$25,384,693.73	21.82%	\$22,333,284.14	22.31%
PSDC	\$2,276,722.33	0.38%	\$57,000.00	0.16%	\$1,167,501.15	1.00%	\$1,135,501.15	1.13%
PSOL	\$165,385.19	0.03%	\$1,011.00	0.00%	\$40,612.07	0.03%	\$39,612.07	0.04%
PT	\$68,340,149.54	11.30%	\$8,303,820.70	23.09%	\$12,131,429.46	10.43%	\$9,337,829.46	9.33%
PT do B	\$914,965.20	0.15%	\$100,000.00	0.28%	\$127,832.05	0.11%	\$27,832.05	0.03%
PTB	\$26,738,274.88	4.42%	\$645,850.00	1.80%	\$4,081,110.33	3.51%	\$3,719,760.33	3.72%
PTC	\$1,516,991.52	0.25%	\$16,200.00	0.05%	\$186,873.50	0.16%	\$175,673.50	0.18%
PTN	\$404,097.75	0.07%	\$52,000.00	0.14%	\$41,626.00	0.04%	\$41,626.00	0.04%
PV	\$13,241,005.15	2.19%	\$927,051.66	2.58%	\$2,036,406.87	1.75%	\$1,523,230.21	1.52%
Total	\$603,817,113.66	100.00%	\$35,968,645.75	100.00%	\$116,242,346.53	100.00%	\$100,050,303.42	100.00%

Source: Author's calculation based on TSE, Petrobras, and Federal Government

Table A5.2: Campaign donations by different groups (2010)

Party	All firms (non Petrobras)		Petrobras' suppliers		Federal contractors		Federal contractors (non Petrobras)	
	Total per party	Share	Total per party	Share	Total per party	Share	Total per party	Share
DEM	\$81,296,485.13	7.91%	7796761	8.39%	18242005.57	7.29%	\$14,095,005.57	7.01%
PC do B	\$16,012,435.57	1.56%	1121200	1.21%	4729694.4	1.89%	\$4,210,494.40	2.09%
PDT	\$42,804,706.97	4.17%	2830330.18	3.05%	10787897.86	4.31%	\$10,043,377.68	4.99%
PHS	\$3,373,148.79	0.33%	686374	0.74%	1068049.5	0.43%	\$480,625.50	0.24%
PMDB	\$180,290,144.36	17.55%	15308640.35	16.48%	34228917.67	13.68%	\$24,684,157.40	12.27%
PMN	\$18,728,866.38	1.82%	110485	0.12%	2573692.34	1.03%	\$2,541,492.34	1.26%
PP	\$50,466,654.88	4.91%	5619901	6.05%	10840442.52	4.33%	\$8,336,361.52	4.15%
PPS	\$29,307,809.18	2.85%	2721339	2.93%	7715309.84	3.08%	\$6,077,147.84	3.02%
PR	\$46,726,482.10	4.55%	3719000	4.00%	8827987.62	3.53%	\$6,277,987.62	3.12%
PRB	\$4,411,501.14	0.43%	65450	0.07%	742758.12	0.30%	\$692,458.12	0.34%
PRP	\$3,298,073.36	0.32%	209500	0.23%	508592	0.20%	\$407,092.00	0.20%
PRTB	\$3,032,483.83	0.30%	60000	0.06%	704242.3	0.28%	\$654,242.30	0.33%
PSB	\$61,372,773.36	5.97%	4914300	5.29%	10924234.12	4.37%	\$7,973,934.12	3.96%
PSC	\$16,503,204.89	1.61%	398712	0.43%	1674703.91	0.67%	\$1,611,657.91	0.80%
PSDB	\$200,053,678.20	19.47%	18102139.9	19.49%	52019584.47	20.80%	\$41,956,733.10	20.86%
PSDC	\$1,196,012.80	0.12%	193240	0.21%	300086	0.12%	\$106,846.00	0.05%
PSL	\$7,299,524.22	0.71%	107800	0.12%	1657795.91	0.66%	\$1,569,995.91	0.78%
PT	\$180,299,366.67	17.55%	24468418.5	26.34%	63351248.49	25.33%	\$52,774,182.49	26.24%
PT do B	\$3,789,809.37	0.37%	107500	0.12%	541417.44	0.22%	\$436,417.44	0.22%
PTB	\$45,067,624.10	4.39%	2313100	2.49%	10769304.4	4.31%	\$9,537,304.40	4.74%
PTC	\$2,721,143.70	0.26%	131000	0.14%	436077.5	0.17%	\$406,077.50	0.20%
PTN	\$3,670,914.01	0.36%	149009.96	0.16%	660151.89	0.26%	\$511,641.93	0.25%
PV	\$25,060,631.89	2.44%	1767924.67	1.90%	6810608.28	2.72%	\$5,722,608.28	2.85%
Total	\$1,026,783,474.90	100.00%	\$92,902,125.56	100.00%	250114802.2	100.00%	\$201,107,841.37	100.00%

Source: Author's calculation based on TSE, Petrobras, and Federal Government

Table A5.3: Campaign donations by different groups (2014)

Party	All firms (non Petrobras)		Petrobras' suppliers		Federal contractors		Federal contractors (non Petrobras)	
	Total per party	Share	Total per party	Share	Total per party	Share	Total per party	Share
DEM	\$35,899,632.31	3.01%	\$2,110,800.00	1.99%	\$3,978,634.03	2.36%	\$3,772,634.03	2.63%
PC do B	\$13,886,215.16	1.16%	\$799,015.08	0.75%	\$2,053,710.88	1.22%	\$1,672,710.88	1.16%
PCB	\$4,377.28	0.00%	\$0.00	0.00%	\$0.00	0.00%	\$0.00	0.00%
PDT	\$42,447,302.59	3.56%	\$930,000.00	0.88%	\$5,212,406.20	3.09%	\$4,842,406.20	3.37%
PEN	\$5,103,235.88	0.43%	\$50,000.00	0.05%	\$768,132.37	0.46%	\$768,132.37	0.53%
PHS	\$3,915,110.05	0.33%	\$92,000.00	0.09%	\$799,585.36	0.47%	\$797,585.36	0.56%
PMDB	\$153,760,895.75	12.88%	\$8,846,365.53	8.36%	\$20,694,526.77	12.27%	\$17,921,161.24	12.47%
PMN	\$2,810,817.29	0.24%	\$11,050.00	0.01%	\$434,472.00	0.26%	\$434,472.00	0.30%
PP	\$48,137,430.52	4.03%	\$4,411,000.00	4.17%	\$4,676,499.64	2.77%	\$4,093,499.64	2.85%
PPL	\$1,961,218.89	0.16%	\$45,000.00	0.04%	\$172,550.00	0.10%	\$147,550.00	0.10%
PPS	\$18,936,959.97	1.59%	\$1,020,000.00	0.96%	\$3,001,292.29	1.78%	\$2,896,292.29	2.02%
PR	\$24,719,111.57	2.07%	\$762,500.00	0.72%	\$5,788,159.91	3.43%	\$5,513,159.91	3.84%
PRB	\$7,995,491.56	0.67%	\$410,500.00	0.39%	\$473,738.26	0.28%	\$473,738.26	0.33%
PROS	\$24,025,820.68	2.01%	\$1,161,000.00	1.10%	\$3,087,402.53	1.83%	\$2,246,402.53	1.56%
PRP	\$3,372,892.66	0.28%	\$83,000.00	0.08%	\$181,818.60	0.11%	\$158,818.60	0.11%
PRTB	\$2,343,870.69	0.20%	\$13,020.00	0.01%	\$641,182.22	0.38%	\$641,182.22	0.45%
PSB	\$71,942,967.47	6.03%	\$4,575,671.05	4.32%	\$13,909,221.48	8.25%	\$12,109,731.48	8.43%
PSC	\$12,503,291.58	1.05%	\$386,263.42	0.36%	\$2,047,052.69	1.21%	\$1,956,589.27	1.36%
PSD	\$71,483,801.38	5.99%	\$3,009,600.00	2.84%	\$8,472,445.57	5.02%	\$7,130,445.57	4.96%
PSDB	\$173,039,281.56	14.49%	\$12,007,380.00	11.35%	\$25,066,900.20	14.86%	\$22,902,400.20	15.94%
PSDC	\$2,432,682.89	0.20%	\$75,000.00	0.07%	\$447,476.70	0.27%	\$447,476.70	0.31%
PSL	\$7,709,316.18	0.65%	\$103,840.00	0.10%	\$714,644.88	0.42%	\$710,804.88	0.49%
PSOL	\$257,563.52	0.02%	\$0.00	0.00%	\$1,508.00	0.00%	\$1,508.00	0.00%
PSTU	\$2,228.66	0.00%	\$0.00	0.00%	\$0.00	0.00%	\$0.00	0.00%
PT	\$392,579,395.89	32.88%	\$62,056,500.00	58.64%	\$57,679,145.62	34.20%	\$44,828,145.62	31.20%
PT do B	\$4,674,480.28	0.39%	\$472,001.00	0.45%	\$692,100.00	0.41%	\$296,100.00	0.21%
PTB	\$31,259,403.41	2.62%	\$1,205,967.50	1.14%	\$2,905,346.82	1.72%	\$2,399,379.32	1.67%

PTC	\$2,986,601.77	0.25%	\$20,600.00	0.02%	\$267,990.00	0.16%	\$267,990.00	0.19%
PTN	\$4,137,918.09	0.35%	\$80,000.00	0.08%	\$692,332.00	0.41%	\$682,332.00	0.47%
PV	\$15,810,720.62	1.32%	\$653,559.00	0.62%	\$2,160,569.19	1.28%	\$2,001,760.19	1.39%
SD	\$13,728,374.88	1.15%	\$442,250.00	0.42%	\$1,636,869.21	0.97%	\$1,586,869.21	1.10%
Total	\$1,193,868,411.03	100.00%	\$105,833,882.58	100.00%	\$168,657,713.42	100.00%	\$143,701,277.97	100.00%

Source: Author's calculation based on TSE, Petrobras, and Federal Government

Chapter 6:

Geology, not institutions: Malaysia's oil industry success amidst strong ethnic distributive pressures

1. Introduction

In 2014, Petroliam Nasional Berhad, or Petronas, reached its 40th anniversary with many accomplishments to celebrate. It was Malaysia's most important company – the only one to figure in the Fortune 500 list – and an international symbol of the country with its headquarters in the twin towers in Kuala Lumpur and its logo on the winning Mercedes Formula 1 racing team. Born out of humble beginnings as a task force to negotiate contracts with oil majors (Hashim 2004), Petronas posted revenues of \$94 billion (Petronas 2015) in that year and, like other National Oil Companies (NOCs), has served as a main source of funding to the public treasury. However, unlike most NOCs, Petronas became a fully integrated oil company with operations in more than 40 countries and with over a quarter of its reserves outside its privileged national market – a feature only surpassed by the Norwegian NOC Statoil. Through its training and procurement strategies, Petronas has also been instrumental in developing a national oil and gas (O&G) supply chain and fulfilling ethnic mandates of Malaysia's New Economic Policy (NEP) aimed at promoting ethnic Malay businesses and workers.

All of these outcomes have been achieved despite a fragile institutional basis. As shown in Figure 6.1, based on the Resource Governance Index (2013) data, Malaysia stands as a major outlier in terms of its institutional and legal setting and its business environment for investment. The country shows an unexpected good “enabling environment” despite its very poor institutional setting regarding the formal rules that governs the resource sector, such as transparency requirements and licensing process. Furthermore, the political and institutional conditions at the time that Petronas was created were no less challenging and would have leaved little room for optimism. Since early on, Petronas had to follow a dual mandate: serve as the custodian of Malaysia's O&G with a mission to maximize the commercial benefits of the exploitation of the national resources and as a vehicle for the development of the nation. That includes the promotion of ethnic Malay businesses and workers according to the politically controversial quotas of the NEP and its successors. Petronas is also both a regulator of the oil sector in Malaysia and an operator, setting policies and awarding contracts to foreign and local oil companies while simultaneously competing with them – a situation that could bring obvious conflicts of interest, inhibiting investments. The company is whole-owned by the state, with no publicly traded

shares and minority investors to monitor management’s performance, and is directly linked to the Prime Minister, who can issue orders to the company, according to the section 3 of the 1974 Petroleum Development Act that created Petronas.¹⁰⁵

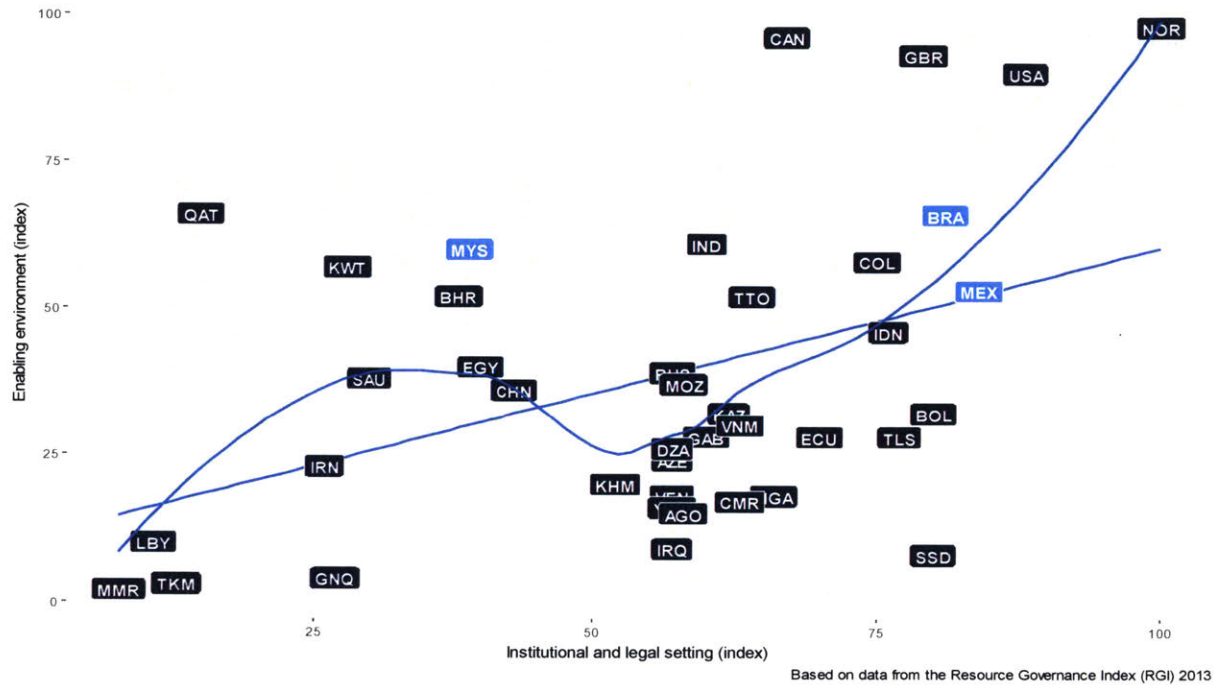


Figure 6.1: Formal natural resource institutions and business environment

This chapter shows that the high cost of production (i.e., this study’s key independent variable), in Malaysia had a direct influence on the bargaining power of actors who shaped the rules of distribution of the oil sector, which secured participation of private companies, under decreasing government take over the years, and subject to a strong local content policy. In the mid-1970s, the Malaysian government could not expropriate resources due to capital and technical capacity constraints. However, it was able to reach deals with international oil companies (IOCs) through a regulator (Petronas) that ensured the transfer of knowledge to locals, used oil wealth to sponsor scholarships, and

¹⁰⁵ Article 2 of section 3 of the Petroleum Development Act (PDA) reads “The Corporation shall be subject to the control and direction of the Prime Minister who may from time to time issue such direction as he may deem fit.” The article that follows leaves no doubt about the extent of the power of the Prime Minister regarding Petronas: “Notwithstanding the provisions of the Companies Act 1965, or any other written law to the contrary, the direction so issued shall be binding on the Corporation.” To Aris (2008, p.116), the section has been controversial throughout its history but Petronas managed to function like any other commercial entity.

channeled the procurement of oil companies operating in Malaysia to locally owned firms, redistributing wealth to ethnic Malays. In the process of capability building and knowledge transfer, Petronas ventured to become an oil operator itself. Seeking to grow outside Malaysia, given the limited reserves at home, it grew to be a fully integrated oil company with wide international presence by the 1990s. In order to sustain production domestically and to attract more investors, as fields become more and more complex and costly to produce, Petronas has never reneged on its contracts and has linearly reduced the government take over the years.

The geology-based account developed in this dissertation helps to explain the trajectory of Petronas within its institutional environment, which is quite puzzling to the resource curse literature. A company subject to a double bottom line (commercial and social, including ethnic preferences in contracting), that serves both regulatory and operational functions, and is not shielded from political pressures, but instead subject to direct control by the Prime Minister, would likely fail in pursuing both a commercial mission and a social redistribution one. In fact, we would expect it to rank at the bottom of international indexes of performance, according to the mainstream literature on governance of state companies (see, for instance, Musacchio and Lazzarini 2014, Shleifer and Vishny 1998). Petronas completely deviates from “best practices” manuals by not separating policymaking, regulatory and operational functions of the oil sector; by not putting in place institutions that eliminate political influence of the company; and by pursuing ethnic distributive goals as part of its operations. Yet, it is highly profitable, with an aggressive investment plan in technology-intensive assets, such as unconventional oil production, and is considered to be “efficient and honest” (Stiglitz 2007, p. 39), “quite professionally run” (Slater 2010, p. 153), and a role model for other NOCs (Marcel 2006).

The standard resource curse literature, which stresses how institutions are fundamental to prevent public predation over natural resources, fails to provide an explanation for the success of the oil sector in Malaysia. No institution actually constrains the power of the Prime Minister in using Petronas for political gains or private investors from facing sudden regulatory changes that could decrease their investment return. This chapter is motivated by these puzzling facts about Malaysia’s rules of distribution of the oil sector and governance. Building upon the framework developed on Chapter 2, it analyzes and explains the evolution of the rules that govern the oil sector in terms of the role taken by the NOC and private companies, government take, and procurement strategies (local content policies). It argues that Malaysia’s geological endowment of limited reserves and of higher cost offshore O&G, which has lower rents per barrel and more production challenges, is the key to understand the

development of its oil industry. These features created incentives for courting long-term investments by private oil companies – which were never nationalized or blocked from investing – transfer of technologies, and efficient business practices in the NOC so it could sustain investment levels in the industry.

Rather than through formal institutions with checks and balances, Petronas has reduced transaction costs and secured investments from major oil companies through repeated interactions that create trust, thus compensating for the lack of “ideal” institutions. Buildup of favorable reputation through repeated interactions is more costly and harder to achieve, particularly for intertemporal transactions between anonymous players, but this channel has long been recognized in the institutionalist literature as a way to reduce uncertainty and facilitate exchange (Greif 1993, North 1990, V. Smith 1998). Given Malaysia’s small reserves and complex technology needed to develop them, the cost of reneging on the terms of contracts is high for the Malaysian state. These two factors have served as a credible commitment mechanism for investors and as a restraint on excessive political interventions in the oil company, a move that could promote short term rent distribution at the cost of impeding rent creation.

As a state company, Petronas must balance this efficiency imperative with strong political pressures coming from Malaysia’s tense ethnic divisions and policies aimed at reducing economic disparities between the bumiputera, or the “son of the soil,” and other ethnic groups, particularly the wealthier Chinese. As elaborated in Chapter 2, high cost oil provides more opportunities for jobs and contracts, creating conflicting incentives between rent-seeking for privileged access to the state oil company and the efficiency required to develop fields of lower rents per barrel. A way to expand the domestic productive capacity while attempting to minimize the cost of production is through industrial policies that coordinate public and private investments. This is exactly what is observed in Malaysia. In order to develop a domestic supply industry which would provide jobs for Malaysians, and Malays in particular, and to foster a bumiputera business class, since its inception Petronas adopted local content policies that favored the participation of at least minority ownership bumiputera capital to all suppliers. In order to accommodate this social imperative with economic efficiency, Petronas invested in funding scholarships to Malaysian workers – with preferences to the bumiputera – and in industrial policies that would increase the participation of Malaysian companies in its total purchases. Overall, Malaysia is a case of remarkable stability in terms of rules in the natural resource sector, of linear reduction of government take over the years, and a strong local content policy.

This chapter is divided as follows. After this introduction, Section 2 addresses Malaysia's history, with a focus on the ethnic cleavages that characterize the politics of the country. Section 3 lays out the theoretical expectations based on the theory elaborated in Chapter 2 of this dissertation and how it contrasts with standard resource-curse accounts. Section 4 does a process-tracing of the development of the oil industry in Malaysia and its rules of distribution of oil wealth and finishes with an assessment of alternative hypotheses and a discussion of the limitations of a geological constraint perspective. Finally, Section 5 concludes by underlining how the Malaysian experience highlights how geological challenges can be both a source of constraints to executives but also opportunities to fulfill distributive pressures in the form of jobs and contracts for local companies, situating the Malaysian case in comparison to Brazil and Mexico.

2. Malaysia: challenges of nation-building in a multi-ethnic society

When the British left the colonial rule of what was previously known as British Malaya, in 1957, an independent multi-ethnic country with deep religious divides and economic disparities was born. Malaysia's ethnic composition at the time of independence was directly influenced by colonial policies and the push to develop a commodity-based export economy that sidelined local ethnic Malays. British rulers stimulated the mass migration of workers from China and India to staff plantations of export crops like rubber, mining operations of tin, and urban services and shops. This had the effect of diluting in numbers, as well as creating economic disparities, between the indigenous population – or the “sons of the soil” (bumiputera, mostly Malays) – and the “foreign” ethnic groups. The Chinese, in particular, thrived in urban areas and accumulated wealth as traders and entrepreneurs, while Malays lived mostly in less dynamic rural areas or were employed in government jobs. At the time of *Merdeka*, Malaya's independence on 31 August 1957, Malays were just about half of the population, with 49.8%, while the recently-migrated Chinese, the second largest ethnic group, had 37.2%. Indians were 11.3% and other ethnic groups summed to 1.8%. In comparison, in 1835, before the British colonial rule, Malays composed 85.9% of the total population of Malaya, with 7.7% being of Chinese origin (Hwang 2003).

Japan occupied Malaya from 1941 to 1945, during the Second World War. With the end of the war and Japan's defeat, the British regained the possession of the country, but started to prepare to leave Malaya and hand the administration to locals. One of the early points of contention was the issue of citizenship. Malay leaders, grouped under the United Malays National Organisation (UMNO), formed

in 1946, initially rejected extending citizenship rights to non-Malays, as proposed by the British. The ensuing negotiations with the British in order to secure independence from colonial rule resulted in a compromise: a parliamentary constitutional monarchy¹⁰⁶ was born with voting rights for the broad resident population. In exchange, Malay leaders secured Islam as the official religion of the country, Bahasa Malaysia as the country's language, and special economic rights to Malays, such as quotas for civil service and educational scholarships as a form of affirmative action.

The large share of non-Malay voters in non-heterogeneous districts, combined with the negotiated way that the nation was born, led to a ruling government composed of a multi-ethnic coalition of parties divided along ethnic lines. Since independence the country has been ruled by the Alliance and its successor, the National Front, or Barisan Nasional (BN). The BN is a coalition led by UMNO with the Malaysian Chinese Association (MCA) and the Malaysian Indian Congress (MIC) as main partners. Opposition parties, like the Pan-Malaysian Islamic Party (PAS) and Democratic Action Party (DAP), are also largely identified along ethnic lines. Scholars and observers of Malaysian politics frequently point out that "ethnicity completely dominates political life in Malaysia" (Puthuchery 2005, p. 2).¹⁰⁷ After a multi-ethnic coalition was in place and the electorate was extended to include most residents of Chinese and Indian descent, electoral incentives to compromise became self-reinforcing in Malaysia (Horowitz 1989).

The elite pact that produced a consociational or power-sharing type of government, to which Malaysia has been referred as a major example (e.g. Lipjhart 2008), was severely challenged by ethnic riots on May 13 of 1969, following an election where the Chinese opposition had a strong showing and celebrated with street parades on 11 and 12 May. This sparked a violent reaction, with 196 killings in Kuala Lumpur, as well as massive loss of property that affected mostly the Chinese community (Hwang 2003, Soong 2007). A state of emergency was declared and, shortly after, the more accommodating prime-minister Tunku Abdul Rahman was replaced by his deputy Tun Razak, who had the support of a younger and more radical faction of UMNO. As a political response to the crisis, the government tilted the cabinet composition even more in favor of Malays and restricted political expression with new or revised laws, including the Internal Security Act (ISA) and the Official Secrets Act (OSA), curbing the disclosure of public information and limiting accountability mechanisms. The government arrested

¹⁰⁶ Malaysia adopted an elected monarchy system, where the traditional state leaders (sultans) select, among themselves, the next Yang di-Pertuan Agong (the monarch and head of the federal state) for the next five years. The power of the monarch is basically restricted to religious (Islamic) matters.

¹⁰⁷ Although campaigns have become more complex and competitive. See Weiss (2014).

opposition leaders, restricted trade union activities, banned leftist parties and even the public discussion of “sensitive issues” (such as Malay special rights).

The economic response came in the form of the New Economic Policy (NEP), an ambitious social engineering program designed to “reduce and eventually eradicate poverty” and the “identification of race with economic function” (Economic Planning Unit 1971, p.1). In practice, the NEP was meant to “correct racial economic imbalance” by raising the living standards of Malays and their share in the category of managerial, professional and technical workers. Rather than pursue direct expropriation of wealth in the hands of the Chinese, the government used the NEP to allocate future business, professional, and educational opportunities preferentially to the bumiputera. The NEP represented a major departure from the predominantly laissez-faire economic policy, which prevailed from independence until the ethnic riots of 1969, to interventionist policies. The Malaysian state started to assume the role of an economic planner as well as direct producer through State Owned Enterprises (SOEs), with the purpose of promoting inter-ethnic redistribution (Jomo 1999).

The two main NEP targets were: (a) the reduction of poverty in Peninsular Malaysia from 49% to 16% between 1969 and 1990; and (b) the restructuring of wealth ownership in favor of the bumiputera, growing their share from 1.5% to 30% by 1990. Through incentives and coercion, the plan sought to “ensure the creation of a Malay commercial and industrial community” (Economic Planning Unit 1971, p.6). In addition to public credit and development programs targeted at the bumiputera, the NEP also imposed ethnic quotas in public-funded higher education centers and the civil service, with some positions in the government favoring the bumiputera by a four to one quota allocation (Boo 1998). The quota system even reached the private sector, as the Investment Coordination Act (ICA) of 1975 mandates that manufacturing companies have to reserve at least 30% of their equity for bumiputera ownership (Gustaffson 2007). While the NEP largely achieved its targets, it fostered rent-seeking and cronyism as government-determined business opportunities were allocated on the basis of ethnic preference and political connections (Jomo 1989, 2004).

The NEP and the development programs that followed were strongly influenced by the 1969 events that disrupted the consociational bargaining that secured political hegemony to the Malays and economic power to the Chinese. Going forward, UMNO would solidify its grip on power and reduce the sphere of influence of its partners in the multi-ethnic coalition Barisan Nasional. It would also restrict the free expression of dissent in civil society, even in its own ranks, and restructure the economy in favor of the Malays. As the future prime-minister (from 1981 to 2003) Mahathir Mohamad wrote in an

influential book published in 1970, between economic efficiency and distributive pressures in favor of the Malays, the government should stick to the latter: “The Malay dilemma is whether they should stop trying to help themselves in order that they should be proud to be the poor citizens of a prosperous country or whether they should try to get at some of the riches that this country boasts of, even if it blurs the economic picture of Malaysia a little [*sic*].” (Mahathir 1970, p. 61).

It was in this newly independent and deeply divided society, increasingly authoritarian, and with strong distributive pressures, that foreign companies started to prospect for oil in the mid-1960s and new reserves were found in the early 1970s, such as the Tembungo and Samarang fields in the state of Sabah, between 1971 and 1973 (Siddayao 1978, Whittle and Short 1978). Until then, Malaysia had only a miniscule oil production, with 9 thousand barrels per day (kbpd) in 1969, while the neighboring Indonesia was producing 642 kbpd for the same year (BP 2016). However, new discoveries and the optimism driven by the first oil shock in 1973 sparked a government takeover of the oil industry with the creation of Petronas, in 1974.

3. Theoretical expectations

This section briefly reviews the resource curse literature and its expectations as applied to the rules of distribution of the oil sector in Malaysia. It shows that the main takeaway from the literature is that whether resource booms are a curse or a blessing depends on pre-existing institutions that hold politicians accountable and ensure government resources are used in a transparent, impartial and meritocratic manner. Based on the expectations generated by the literature, it is possible to conclude that no worse moment than the mid-1970s could exist for building a new NOC and drafting a legislation to deal with oil rents. Consequently, Malaysia’s success in managing oil resources, promoting a local supply chain and diversifying its economy despite unlikely conditions defies standard theoretical predictions. It does, however, fit well in an analytical model that includes an analysis of the interaction between Malaysia’s geological endowments and its political demands. This perspective uncovers a different source of constraint on inefficiencies and opportunities for developing a local supply chain. Such alternative hypothesis, elaborated in Chapter 2, is then summarized and applied to the Malaysian context of high-cost oil production and ethnic distributive disputes.

The resource curse literature is now a large body of works that started from single case observations, within the tradition of rentier state theories and the disappointment with the growth

record of resource-rich countries in the 1980s, to cross-country generalizations. Its theoretical claims evolved towards a more sophisticated understanding of oil's conditional effects as resource revenues get filtered through a country's institutions.¹⁰⁸ Scholars and development practitioners know well that natural resource abundance is not an unconditional short-cut for development, despite being a potential source of hard currency, when exported, and taxes that can fund much needed public goods. Quite the opposite, commodity bonanzas can trigger ill desired political economy consequences through the availability of substantive rents that easily flow to governments. Oil, in particular, is a most likely case of that phenomena because of the scale of rents that it can command – especially the differential (Ricardian) rent that arises from the large gap that can exist between the cost of production and the sale price. That, coupled with government ownership of subsoil resources and production through state companies, exacerbates the potential negative effects of oil abundance. As Ross (2012) points out, petroleum revenues have distinct political effects than other sources of public funding and such (negative) effects became particularly pronounced in the 1970s, when price volatility increased and governments of oil-rich countries raised their rent capture through nationalizations and the creation of NOCs.

One of the main mechanisms that links how windfalls in the public budget translate to negative outcomes is the soft-budget constraint effect: easy access to resource rents can prompt inefficient redistribution. While unproductive redistribution can make good politics and help with regime survival, it results in bad long term economics. For these reasons, scholars and policy practitioners have emphasized the importance of adopting institutions that enlarge the time horizon of policymakers and constrain their ability to use revenues as they please. Those institutions have received various denominations, such as “impartial” (Kolstad and Wiig 2009), “producer friendly” (Mehlum et al. 2006) or “high-quality” (Robinson et al. 2006). At their core lie mechanisms to regulate public expenditure, impose transparency requirements, secure property rights and hold rulers accountable. The governance and performance of the oil sector would also depend on such institutions and the degree of state involvement in the industry (Luong and Weinthal 2010, Aguilera and Radetzki 2016). High fiscal demands and short-term horizons by the executive can lead to underinvestment by NOCs, limiting future production and technical capabilities.¹⁰⁹ Furthermore, distributive pressures in the form of

¹⁰⁸ Chapter 2 provides a review of the literature on development and natural resource abundance. For general reviews of the resource curse literature specifically, see Ross (2015) and Gochberg and Menaldo (2016).

¹⁰⁹ Mexico's Pemex is a paradigmatic case of underinvestment in productive capacity, as addressed in Chapter 3.

patronage employment and crony suppliers can turn state oil companies into overstuffed, inefficient behemoths.

The predictions that arise from the bulk of the literature is that unless the government of a resource-rich country operates under a set of good institutions, oil rents are likely to be captured by an elite and will be squandered in the form of unsustainable subsidies, white-elephant projects, and corruption. At the limit, weak institutions can trigger a situation where short-term distributive pressures can “kill the goose that laid the golden eggs,” with the oil industry suffering itself from underinvestment in productive capacity and technological capabilities. Malaysia’s oil discovery in the 1960s and subsequent nationalization in the 1970s, under an increasing authoritarian regime with strong ethnic distributive pressures as called for by the NEP, would make a perfect candidate for the curse.

Despite its richness, methodological diversity, and ongoing points of debate, the resource curse literature is mostly a theory about oil rents, not about the oil industry. Furthermore, even the rent aspect of this literature is only narrowly articulated. The prevalent assumption is that if an oil resource exists, its production will necessarily accrue high economic return, which would be true in a world where all resource-owners enjoy high differential or Ricardian rents. While it is correct that countries that are members of the OPEC have the lowest geological risk and production cost in the world (Aguilera 2014), the cost spread outside of OPEC producers can be very high (see, for example, IEA 2015, p. 18), limiting the capacity of resource-owners of more marginally profitable fields (e.g., deep offshore, shale, oil sands) to engage in the same strategies of rent-capture. On the other hand, a resource base that has a high-cost of production and is more technically challenging can induce strategies of rent-creation through innovation rents and the adoption of rules of distribution and institutional complementarities that facilitate investments and shoulder risks and costs. Particularly in these cases, reserve additions, as production goes from good ore to bad and from bad to worse – and high cost producers already start from a comparatively “bad” ore – are no gift of nature, but a result of “a growth of knowledge, paid for by heavy investment” (Adelman 1995, p. 17).

The heavy investment – in knowledge and capital goods – required to find and extract oil from more challenging geologies has political consequences. Production from high-cost oil reserves has a higher demand for capital goods, specialized services, and skilled personnel. For instance, it may require more drilling days, raw materials (drilling mud, pipes, risers, etc.), and support services to output a barrel. This demand will be politically salient as local suppliers can benefit from rules that mandate that oil companies prioritize them in their procurement. Therefore, geological endowments and industry

characteristics can generate incentives for political actors who are involved in setting the rules of the natural resource sector. Those incentives affect the executive power, as a resource-owner, but this branch of government operates under political constraints, which include distributive pressures, veto points from the political system (Krehbiel 1998, Tsebelis 1995), and the bargaining power of business associations and other firms, including IOCs.

Figure 6.2, presented and explained in Chapter 1, shows an analytical model that connects variations on extraction costs, simplified as low or high, with the incentives faced by the stakeholders of the oil industry. Together, the groups bargain over the rules of distribution of the O&G sector.

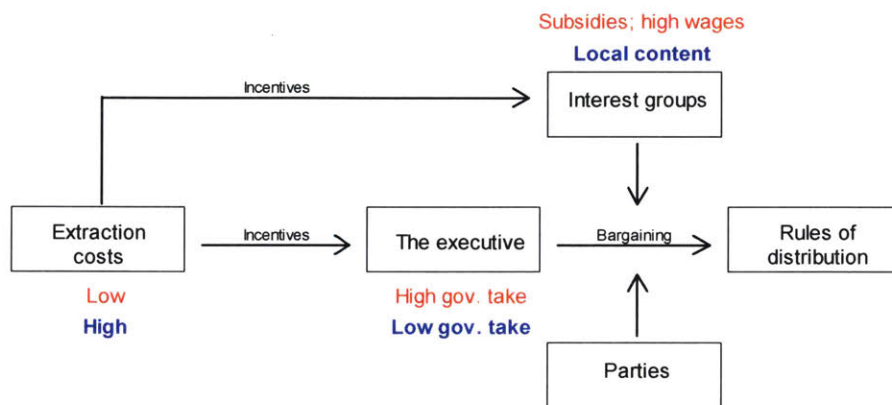


Figure 6.2: From extraction costs to rules of distribution

In short, a geological endowment perspective highlights that endowments vary in their characteristics, rents per unit of output, and what it takes to extract them. All these generate political incentives on the governance of the natural resource sector. Where natural resources are abundant, technically easy and low cost to extract, there will be little incentive to improve the efficiency of production or invest in technology or the supply chain. On the other hand, where resources exist but rents are few, an arrangement to support rent-creation will facilitate the development of the oil industry. However, such arrangement requires an alignment of political incentives to be enacted, and local content may serve as an inducement for interest groups.

The theory summarized here allows us to predict that high-cost resources will influence the design and evolution of the rules of distribution of the oil sector. Limited reserves with high-cost of production trigger incentives to manage the resource sector, and distribute its gains, in a way that both promotes continued investment in productive capacity as well as local supply. It can be institutionalized in formal rules, as the case of Brazil and Mexico (after the 2013 energy reform) addressed in the

previous chapters, or through repeated interactions as happened in Malaysia, despite an institutional environment that remained weak in terms of accountability.

To contrast the predictions generated by the standard resource curse theory with the geological endowment perspective outlined in Chapter 2 and summarized above, the following section proceeds with a process-tracing of the historical development of the oil industry in Malaysia. It shows that since the beginning, with the creation of Petronas and early negotiations with IOCs, the cost of extraction and technological requirements influenced the tax regimes and the policies to localize investments set by the Malaysian government. The opportunities created by high-cost and technically challenging resources were utilized to meet ethnic pressures for increasing the asset ownership and employment in technical and managerial positions of the bumiputera, helping to fulfill the NEP targets.

The section that follows is based on two fieldwork trips to Kuala Lumpur where I conducted archival research, interviews and participated in the main conference of the industry in the region (OTC Asia 2016). The archival research was carried predominantly at the National Library of Malaysia, searching for all documents related to the oil industry in the country and Petronas. It was complemented with research at the library of the Central Bank and the National Museum. For interviews, like in the other empirical chapters, I sought a sample of the main stakeholders of the oil industry and informed observers. That includes Petronas, private operators, suppliers, and governmental entities such as the Malaysia Petroleum Resources Corporation (MPRC). When authorized by interviewees, names and dates are listed at the end of the chapter. Because Malaysia does not separate policymaking, regulatory, and commercial activities, unlike Brazil and Mexico, I sought people within Petronas from different areas, including supplier development, human resources, technology and regulations, reaching five senior employees. Four of them preferred to not publicly disclose their names, an option mentioned in the informed consent. Nonetheless, they have provided extremely valuable background information on the business practices and their own career path. Some informants preferred to remain anonymous and are not listed, including a very senior executive of an IOC which operates in Malaysia.

4. The creation of Petronas and negotiating with oil majors

4.1. From early explorations to the creation of Petronas

Oil was first extracted in Malaysia in 1910, in the state of Sarawak. At the time, it was a small onshore field operated by the Anglo Saxon Petroleum Company, the predecessor of Shell, which acquired the exploration rights from the British colonial government. Production peaked in 1929 with 15 kbpd (Hui 2012) and no other significant onshore discovery has been made since. Starting in the 1960s, six oil companies acquired concessions to explore Malaysia's offshore resources, which could be done directly from state governments, with little oversight and minimum taxation. Shell, again, was successful, with the first offshore oil produced in 1968 from the West Lutong field in Sarawak, with about 3 kbpd (Ghouse 1997). Exxon, which started exploring in 1965, would discover the offshore Tapis field (offshore the Terengganu state) in 1969, but production would only begin in 1978. The same company discovered the Tembungo field, offshore the state of Sabah, in 1971. Both fields were complex and located in water depths between 64m to 84m.¹¹⁰ The final decision to fully invest in exploiting the fields would depend on the outcome of negotiations with the federal government of Malaysia, which by 1974 announced its intention to completely revamp the regulatory framework of the country. Malaysia's move followed a wave of resource nationalism and the growing bargaining power of oil-rich states, particularly those from the Organization of the Petroleum Exporting Countries (OPEC), which in 1973 promoted the first oil embargo which skyrocketed oil prices.

In order to capture more of the oil rents, the Malaysian government decided to change the rules and assert more control over its natural resources. After a brief experiment to manage the oil sector through a government entity called Hydrokarbon Malaysia (HIKMA), the administration of Tun Abdul Razak, Malaysia's second prime minister, decided to constitute Petronas as a company, wholly-owned by the government but incorporated in the private sector, following the 1965 Companies Act. The parliament approved the Petroleum Development Act (PDA) which created Petronas by granting the new company exclusive rights to petroleum exploration and exploitation in Malaysia.

On August 17, 1974, Petronas was set up as a business entity, the only business of which was to represent the economic interest of Malaysia in the oil industry. Composed of politicians, lawyers, economists and accountants, not a single engineer or geologist was part of the founding team (Bowie

¹¹⁰ Both discoveries were on sandstones with high-quality light oil, particularly Tapis, which became a benchmark crude for the region. However, field development faced several hurdles. In the contemporary technical literature, Tembungo is referred as having an "extreme structural complexity" (Whittle and Short 1978, p. 31) and being "an extremely difficult reservoir to produce" (Whittle and Short, p. 30). Tapis was more promising in terms of total recovery of oil in place and amount of reserves, but required intensive drilling (70 development wells, in the 1981 development plan), careful management of reservoir pressure and production revisions: "Tapis is a complex field that has undergone several major changes in its development plan." (Thu et al. 1983, p. 1060).

2001, Gale 1981a). Since early on the administration was heavily bumiputera – the first chairman was Tengku Razaleigh, a 36 year old prince from the state of Kelantan and former head of Bank Bumiputra. As Bowie (2001) puts it, Petronas was one of the earliest institutions of the country in line with the aspirations of the NEP and the idea of creating a Malay commercial class.

The Petronas management team had two immediate battles to fight. The first was an internal one: gaining the acceptance of other states, particularly Sarawak and Sabah, on the federal claim for resource ownership and exclusive rights over the entire country. The states were the first veto point in the consolidation of Petronas as the only representative of Malaysia in deals with the major oil companies. Through a combination of political pressure and short-term compensation (Gale 1981a), negotiators from the federal government successfully made state legislative assemblies accept, by a two-thirds majority, the rights of Petronas in exchange for a 5% share of royalties of the total 10% charged from all oil production. The arrangement represented a drastic centralization of decision making and revenue in the hands of the federal government, as all aspects of the oil management from now on would be in the hands of Petronas (Moorthy 1983). In addition to half of the royalties charged on oil production, the federal government also benefits from a share of the production, an income tax, and export, import, and excise duties. The high asymmetrical revenue sharing regime has led, over the years, to requests made by producing states to raise their portion of the revenues (Hui 2012).

The second battle was to negotiate with oil companies an arrangement that would safeguard the interests of the government in increasing the rent capture and promoting a bumiputera business class while securing to them a comfortable rate of return and protection for their investments. Malaysian officials had, at the beginning, high expectations of how much revenues they could extract from oil companies. However, oil company executives would remind them that their assets were not as precious as what could be found in the Middle East or even in the North Sea, and that they would lose investments if insisted on high government take. "You can't just put down a drill anywhere you want, as in the Middle East, and out it bubbles. That's been Malaysia's problem. They think they're Saudi Arabia," said one executive in 1975 (Gale 1981a, p. 1132).

With negotiations stalled, in 1975 Exxon pressured the Malaysian government by suspending all exploration activities in Malaysia and halting the completion of two platforms in shipyards – using its structural power to refrain from investing. Exxon was costly signaling their position, as the decision represented an estimated loss of production of 40,000 barrels per day to the company. However, it also imposed costs to Malaysia, since much of the M\$100 million budgeted investment would flow to

Malaysian contractors (Gale 1981a). While Malaysian officials knew that the international conditions were favorable for oil-rich countries (Moorthy 1983), they faced a weaker bargaining position compared to conventional oil producers from OPEC.

Without experience in the sector, Petronas constituted a task force to study how the oil industry worked in other countries, such as Indonesia and Saudi Arabia, so they could have a sense of how much they would be able to push oil majors before they decided to break negotiations and leave Malaysia. Three critical points became clear to the negotiating group from the Malaysian side: 1) the country lacked the technology to extract offshore O&G resources, so it had to entice the international companies to keep investing; 2) the cost of production in Malaysia was higher than in other oil-rich countries, so contractual arrangements and the government take would have to be adapted to reflect Malaysia's geological characteristics; and 3) the financial resources required to expropriate and compensate oil majors which had ongoing investments – mainly Shell, Exxon and Conoco – were too high, so full expropriation was not a credible threat, in addition to a lack of local capabilities to take over operations (Hashim 2004). As Rastam Hadi, the first managing director of Petronas, puts it, "Shell and Exxon had all the technology required whereas, on the nation's side, there was not a single local organization that could depend on to take their place." (Hashim 2004, p. vi). Furthermore, reserves discovered so far were far from the levels found in Middle Eastern countries or even Indonesia¹¹¹, so it was necessary to adopt a careful strategy to manage the sector (Bowie 2001, p. 37).

Hence, Petronas had to work contractual terms that appeased the domestic distributive pressures at the same time it attracted the investment of oil majors. It did so through replacing the concession system with a production sharing contract (PSC), originally based on Indonesia's model used by its NOC, Pertamina, but changed to reflect Malaysia's less favorable geological condition of small reserves, lack of onshore production and higher cost of production. As Gale (1981a) puts it, political and economic realities made coexistence essential to Petronas and IOCs. The task force found that the average cost per barrel in Indonesia was \$1 to \$1.20, while in Malaysia the cost incurred by Shell was \$2, up to 100% more (Hashim 2004). In comparison, in the Middle East, the average production cost in the 1970s was of around 11 cents per barrel (Maugeri 2006, p. 80).

¹¹¹ While Indonesia has largely avoided the resource curse by having diversified its economy, its NOC, Pertamina, has a history of inefficiency and corruption. An early OPEC member, Indonesia had to leave the organization when it stopped being a net exporter of O&G in the 2000s. On Pertamina, see Hertzmark (2007) and Smith (2007) on Indonesia's oil political economy.

Governments use a range of criteria to allocate exploratory areas and extract economic rent from oil production. In general terms, this includes a combination of direct cash payment (also known as signature bonus), an offer to pay an additional share of production above the minimum established by the host government, and a work program that describes how much efforts in exploration an oil firm commits to do, such as number of wells to be drilled (see, for example, Johnston 2003). Each mechanism can be tailored to serve different political priorities and used in competitive biddings or direct negotiations. For instance, policymakers focused on short-term rewards will try to maximize the signature bonus, which is a direct cash payment before production starts. Countries with large reserves and low geological risk have little incentive to award on the basis of work programs, which is more relevant to frontier areas where the geological knowledge is more limited or production is dwindling.

Malaysia's first PSC contracts were geared towards maximizing investments in exploration and production. The signature bonus was intentionally low, breaking with the practice of Pertamina, and later abolished altogether. In addition to the 10% royalty, a 0.05% tax earmarked to a research fund, and a 15% participating interest, the production share was fixed in contract to start at a 70/30 split in favor of the government (65/35 for gas), but with a sliding scale in case of high production in addition to a windfall profits tax. Malaysia also allowed for a cost recovery, which is a mechanism through which oil companies can deduct their investment before the share of the production that has to be split. However, expenditures had to be submitted and approved by Petronas on a yearly basis. Through this mechanism, the Petronas team had access to all the expenditures made by oil companies, which proved to be valuable to understand the operation of the oil business and to influence their procurement practices. In 1976 Shell and Exxon (operating as Esso, at the time) signed their first contracts under the new regulatory framework, opening the door to other investors.

4.2. Building a market for natural gas

In addition to having small reserves compared to international standards, Malaysia proved to be richer in natural gas rather than crude oil – a disappointing result for oil companies, more interested in crude production. While it is possible to equate production of oil and natural gas in a single metric by their heat content – such as barrels of oil equivalent (boe) – in reality the two commodities have major physical differences that influence their economics of production. Crude oil can easily be transported, stored, and sold in the international spot market. Natural gas has a lower energy density, is harder to

transport and tends to be traded through long-term contracts rather than spot markets. In order to transport natural gas, companies need to invest in long and costly pipelines and/or liquefied natural gas (LNG) tankers. On average, gas is five times more expensive to transport than crude oil (Bret-Rouzaut and Favennec 2011, p. 104) and is sold for a fraction of the price of crude. While LNG tankers allow to the export of the product over long distance, which is not commercially feasible through pipelines, it requires a large infrastructure investment in a liquefaction plant that will pressurize and cool the gas to -163°C (-261°F), shrinking it in volume.¹¹² The methane, now in liquid form, can then be loaded into a LNG tanker. About 10% to 15% of the fuel is consumed in the process of liquefying, transporting and regasifying the gas (Inkpen and Moffett 2011, p. 336). Additionally, there are limited facilities in the world with regasification infrastructure to receive LNG tankers – and consumer markets ready to buy it.

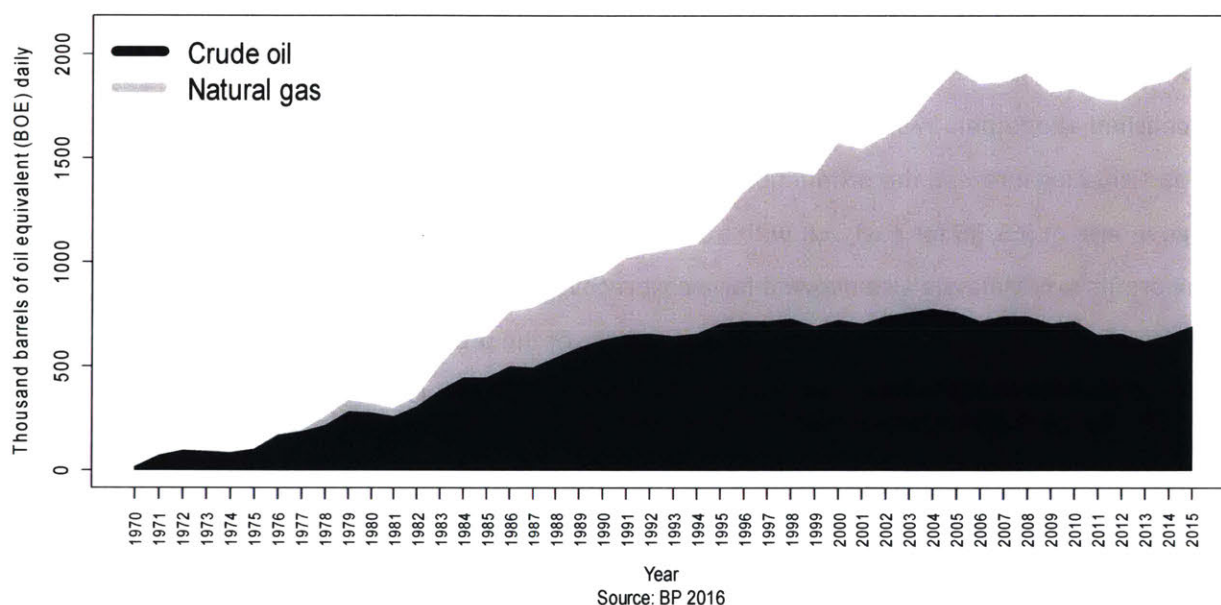


Figure 6.3: Malaysia's hydrocarbon production

In the early days of the O&G industry, natural gas could just be burned (flared) as a byproduct of oil production (for fields which had both) or even abandoned due to a lack of a market for it. In the late 1970s, the market for LNG exports was incipient, but Malaysia was not far from resource-poor Japan and Shell had discovered gas reserves in the state of Sarawak. To monetize the resource would require working out a contractual arrangement that would secure markets and financing for gas production, a

¹¹² Jahn et al. 2008 estimates in \$5 billion the investment necessary today to build a LNG plant.

LNG plant, vessels and a terminal on the consumer side. These integrated contractual arrangements tend to fix price and quantity for the long-term (20 to 30 years), reducing uncertainties for the stakeholders and helping to fund the large capital investment (Inkpen and Moffett 2011). In March of 1978, and after long negotiations, Petronas, Shell, and Mitsubishi formed a joint-venture and committed to a US\$1.3 billion project in a LNG plant in Bintulu, Sarawak.¹¹³ The first LNG vessel would only depart Malaysia to Japan in 1983, as originally planned. Malaysia's gas production would grow to surpass crude output and make this commodity two times more relevant in terms of energy production than crude oil (see Figure 6.3). However, it is worth highlighting, natural gas has lower rents per equivalent unit of heat output, more operational costs to distribute, and is tied to long-term contracts – characteristics that affect the distribution of wealth from the natural resource sector.

4.3. Building a Malay business class through oil contracts (local content)

The high cost of production and more sophisticated technical requirements of offshore oil production were perceived by the Petronas management team as a business and learning opportunity, which would also help them to fulfill their mission to promote the NEP objectives. Since the first contracts were signed, Petronas added a clause on procurement, which required oil companies to buy from licensed companies or agents. By controlling the list of suppliers and vetting the oil companies' yearly work programs, Petronas has implemented industrial policies that aimed to transfer production from abroad to Malaysia and replace expatriates with Malaysian workers.

The move was highly influenced by a belief that Malaysia had such limited reserves that soon the oil in the country would be exhausted. In 1974, reserves were estimated at 0.7 billion barrels (Ghouse 1997, p. 55). "Our greatest fear, at that time, was that we were led to believe that Malaysian oil would only last for 14 years. We thought: we are in our 20s; in 14 years we will have to look for jobs again. So we need to build a service industry," recalls Datuk Ismail Hashim, one of Petronas' first employees and a member of the company's negotiating task force (Interview Hashim 2016). This soft-spoken Malay, now in his early 70s, remembered the humble beginnings of Petronas and the information asymmetry that existed between the IOCs and the Petronas team.

¹¹³ Or RM3.2 billion at historical prices or US\$4.7 billion correcting for US inflation. Later, the state of Sarawak took a 5% share in the project (Bowie 2001).

With the creation of Petronas, each expenditure made by the IOC had to be submitted and justified so it could classify as “cost-oil,” the amount of expenditures that oil companies can recover from production before being obliged to split barrels with the government (“profit-oil”). Shell and Exxon provided Petronas, as a regulator, with information about why they were buying a given service or good, from which company, and from which country. This information flow gave this group of unexperienced executives access to the procurement strategies, purchase prices, and the business rationale of the major oil companies. One of the early conclusions that Petronas’ executives had was that the amount of outsourcing in the industry was high and increasing – with the bulk of the investment going to tier 1 and tier 2 suppliers – and many of the purchases were from companies located in resource-poor Singapore. Despite its geographical closeness, Singapore was politically distant at the time and dominated by ethnic Chinese.¹¹⁴

Without expertise to refute the arguments made by IOCs about the potential for future O&G production in Malaysia, Hashim and colleagues wanted to promote a local supply industry that could, in the future, serve the O&G industry outside Malaysia. Ngau Boon Keat, another of Petronas’ pioneers, was responsible for analyzing the procurement practices of oil companies in Malaysia and helped to create the license requirement, which mandates that oil companies buy only from Petronas-licensed companies:

“That meant all the services moved here from Seria in Brunei and Jurong in Singapore. Otherwise, our people would not even know what a Christmas Tree at the wellhead is. By shifting here, Malaysian engineers and technicians get hired and that is how the technology is transferred.

We looked at the basic issue. In our discussions, we estimated the oil may last some 15 to 20 years. What if we don't find any more oil? What if the oil is depleted? What happens then? We looked at companies like Shell. Shell is from Holland and Holland has hardly any oil yet they own oil fields all around the world.

The reason is that they have the technological know-how. That was something we did not have. We thought, if we just give them the oil field, we will always need them because we cannot do it ourselves. We decided that along the way, we must design a policy that allows the transfer of technology to Malaysian companies while they are still producing the oil. So that in the long run, one day, if we run short of oil, our people who have experience in oil technology can go to other places in the world to look for oil, to produce oil and bring it back.” (Hashim 2004, p.71).¹¹⁵

¹¹⁴ The island state had been part of the Federation of Malaysia from 1963-1965, but was expelled by Prime Minister Tunku Abdul Rahman, with unanimous confirmation by the Parliament, after irreconcilable differences rooted on racial tensions with the majority Chinese island.

¹¹⁵ Ngau Boon Keat worked for Petronas between 1975 and 1980 and in 1984 cofounded Dialog Group, Malaysia’s leading integrated technical services provider to the O&G industry, with current operations in 9 countries

The NOC used its regulatory power to promote business opportunities for locals – particularly the bumiputera. It did so through licensing requirements and coaxing oil companies to replace expatriates with locals (in all hierarchies) via targets set in the yearly work programs of their production contracts.

A requirement of the 1974 PDA law that created Petronas is that all companies that wish to provide goods and services to the upstream sector must have a valid license issued by Petronas. Moorthy (1983, p. 25) goes as far as saying that the main “reason for the decision of the Malaysian Government to enter the petroleum industry and exclude totally or partially the private sector was to implement the New Economic Policy. The objective of the New Economic Policy is to create a Bumiputra commercial and industrial community.” To operationalize this redistributive mission, the company created a public registry of suppliers and defined a list of Standardized Work and Equipment Categories (SWEC) by separating the numerous activities of O&G into specific tasks and goods, each with a list of suppliers. More exactly, there are currently 631 services and 223 goods with unique SWEC codes requiring companies to apply for a license for each one of them.¹¹⁶ By 2017, Petronas had about 3,700 firms registered with Petronas (Jayaseelan 2017).

For instance, an oil company that needs to drill a well may invite several companies to a bidding, as each category (e.g. drilling equipment and services, coring, cementing, well testing) will have a list of companies that meet the technical and bumiputera requirements set by Petronas. The drilling tools rental has a code (SP2020100) while drilling pipe rental another one (SP2020200), and so on (see examples on Table 6.1 below). If it is a service or good that is imported, an international supplier has to set up an exclusive representative agent in Malaysia who constitutes a company of minimum 51% bumiputera capital. If the company has local manufacturing in Malaysia, the bumiputera capital requirement is generally lower: 30%. Companies also have to comply with similar levels of bumiputera in the board of directors, management and employees.¹¹⁷

(http://www.dialogasia.com/corporate_about_dialog.htm). Dialog ranked third in the country in revenue among O&G suppliers, with revenues of MYR 2.5 billion or about \$714 million (MPRC 2015).

¹¹⁶ Author’s calculation based on Petronas spreadsheets available from www.petronas.com.my.

¹¹⁷ See Petronas 2014a for a full description of the complex system of procurement.

Table 6.1: Example of SWEC code specifications (Production / Drilling / Workover Associated Serv.)

Drilling rigs	SWEC code	Minimum Mode of Operation	Minimum bumiputera %
Jackup Oilfield Rig Services	SP2010101	Rig operator / Rig owner	51 / 30
Tender Assisted	SP2010102	Rig operator / Rig owner	51 / 30
Drill Ship	SP2010103	Rig operator / Rig owner	51 / 30
Self Contained/Platform Rig Services	SP2010104	Rig operator / Rig owner	51 / 30
Semi-Submersible	SP2010105	Rig operator / Rig owner	51 / 30

Source: Petronas

The policy was designed to facilitate the entry of local businessmen in the oil industry, from a virtual zero participation when the industry began in the country. First, foreign suppliers had to identify and work with locals in order to sell to the Malaysian market. Starting as a representative of a company, the local agent acquires knowledge of the sector, builds up a relationship with the production chain, and is compensated with a share of the profits. With time, the partnership can evolve to local manufacturing – a move that is stimulated by Petronas through a Vendor Development Program (VDP) that started in 1993 (Ghouse 1997). The VDP guarantees purchases of goods and services of companies that invest in upgrading their capabilities and keep prices within international benchmarks (Interviews with Petronas executives and suppliers 2016).

The result is that Malaysia built a domestic supply sector which is 85% controlled by Malaysian groups, employing more than 400,000 people (Lopez 2012, p. 810), with Malays occupying all hierarchical levels. A ranking of the top 100 suppliers in the Malaysian O&G sector figures local groups in leading positions, such as SapuraKencana (1), Malaysia Marine and Heavy Engineering (MMHE) (2), Dialog Group (3), etc. While these numbers are worthy of celebration to the government, this procurement system comes with costs. International suppliers, such as Schlumberger or Technip, register different companies in order to comply; some firms have the 51% bumiputera capital required to import equipment, while those which have local manufacturing have 30%.¹¹⁸ It is an open secret in the sector that some agents are just frontmen, lending his (bumiputera) name to real owners who actually run the business, or that regulations are circumvented by companies lending money to an employee, who uses the loan to buy stock of the firm, becoming in this way a shareholder and helping to

¹¹⁸ For instance, in the ranking of the top 100 O&G companies in Malaysia, Schlumberger appears three times, as it operates different local subsidiaries following Petronas' license requirements: Schlumberger WTA (Malaysia), in 12th, Schlumberger Drilling Services 26th, and Schlumberger Wellog (M), 57th (MPRC 2015).

boost the bumiputera asset ownership. Furthermore, by dividing the activities of the O&G industry into many discrete tasks that require individual biddings, companies lose economies of scale and projects become more complex to manage than integrated or turn-key packages. These sources of economic inefficiencies (search costs for agents, transaction costs for managing multiple companies, monitoring costs for dealing with several suppliers, etc.) highlight the political nature at the base of this system of procurement. The rationale of the SWEC system is that by separating every activity into a minimum work specification, more can be done locally. The bumiputera requirement guarantees that these ethnic groups will be singled out in receiving oil wealth that comes from oil contracts – either in the form of rent-seeking, when their name is just rented, or as a productive return to talents, when they use their preference in hiring to engage in activities that add value to the firm and expand its business. Pure rent-seeking is constrained by the fact that cost overruns would make investing in Malaysia unprofitable given its less attractive geological prospects (with abundant mature fields).

Unlike local content (LC) mandates in other countries (Tordo et al. 2013), including Brazil and Mexico (after 2014), in Malaysia there is no fixed LC targets as measured by total expenditures per unit purchased. The focus is on the ethnicity of jobs created and capital ownership. The implementation is also more flexible: Petronas can waive the requirement (or strengthen it) in response to market conditions.¹¹⁹ Azhar Abdullah, a Vice-President at Schlumberger Asia, says that the Malaysia government is flexible because it needs the latest technology to maximize oil extraction. “In Malaysia... we want to ensure that we have the best technology to develop our fields. Because our fields are complex, with a very low recovery factor. So you cannot inhibit technology application by going to one extreme [rigid local content]” (Interview Abdullah 2016). In his assessment, a key factor for Malaysia’s success in sustaining production and keeping its position as a net exporter of energy in Southeast Asia has been Petronas room of maneuver to decide the balance between the commercial and technical requirements of production and the country’s political agenda.

Petronas and governmental agencies, such as the Malaysian Investment Development Authority (MIDA) and the Malaysia Petroleum Resource Corporation (MPRC), work on attracting and developing suppliers, such as transforming agents of specific SWEC goods into manufacturers. They also help them with exports and some Malaysian groups have successfully expanded overseas, such as SapuraKencana, Dialog and Bumi Armada. As Najib Tun Razak, Malaysia’s Prime Minister, put it during the launch of its New Economic Model, in 2010, the growth of Petronas is to be tied to the development of local

¹¹⁹ Interviews with Petronas’ executives, suppliers and Madros (2016).

suppliers, including making them expand internationally. “In oil and gas, we have one of our nation’s most visible and valued champions in Petronas. It has built a strong brand internationally, and I believe now we must also help drive growth here in Malaysia with even greater support for local suppliers as it grows... Malaysia’s international energy expertise can help companies in this industry and beyond expand internationally by sharing its know-how, partnering on international bids and offering support on a truly global scale.” (Tun Razak 2010).

4.4. Becoming an oil operator and expanding overseas to sustain the domestic supply chain

Petronas was born as a regulator to represent the interests of the Malaysian state in capturing oil rents, serve as a custodian of the O&G reserves (ensure an adequate replacement of reserves) and promote a Malay business class through its licensing requirements. As a regulator, it was responsible for approving the expenditures of the IOCs and their yearly work programs. This gave Petronas’ management valuable know-how on how oil companies operate, but all the extraction continued to be done directly by IOCs. Four years after the creation of the oil regulator, the Malaysian state made an important bet: make the Petronas team directly compete in the business of finding and producing O&G.

Through the incorporation of the subsidiary Petronas Carigali, in 1978, Malaysia’s NOC started working in an area previously relinquished by Conoco off the East Coast of Peninsular Malaysia, the Duyong field, perceived by Conoco as unattractive for commercial development. To Petronas, this would be a valuable learning opportunity and a way to independently develop the country’s resources. Carigali started to drill appraisal wells in 1980, therefore delimiting the size of the field, with production beginning in 1984. Carigali also prospected in an area previously left by Exxon and, in 1982, found the Dulang gas field. Economic and technical issues would delay the beginning of production, which only started in 1991. Nonetheless, the Dulang field was considered a milestone to the country because it was the first project led by Carigali from exploration to development (Petronas 1992).

Carigali could draw from the first wave of Malaysian students who were sent abroad on government-funded scholarships to learn petroleum engineering and were concluding their studies (Bowie 2001). Since 1975, over 20,600 Malaysian students received a Petronas scholarships to study in

universities at home and abroad (Petronas 2014b).¹²⁰ The subsidiary also benefited from the transfer of knowledge, skills and technology promoted by the Malaysianization policies of replacing expatriate workers by locals, per the terms of the PSC contracts (Balakrishnan 2002, Ghouse 1997, CCSI 2016). Interviewees frequently pointed out that because Petronas operated in a competitive environment at home, it was always benchmarking its practices with oil majors and benefitting from technology transfers.

Soon, the company had enough critical mass to operate their fields within Malaysia. From their home-built capabilities, much like Petrobras with Braspetro (see Chapter 4), it sought external markets to grow. A main driver of its overseas expansion was a need to find new sources of O&G to compensate for Malaysia's declining reserve base (Marcel 2006, p. 197) – a geological push. Being a NOC of a country with limited reserves and mature fields did not look sustainable for business – a challenge that also includes its domestic network of suppliers.¹²¹ The decision had the political support of Prime Minister Mahathir Mohamad (1981-2003), who saw in the move a necessary step to guarantee the sustainability of the company:

“When I became Prime Minister, I urged PETRONAS to reach out abroad. In Tun Hussein Onn's time there had been some talk of increasing trade overseas but the idea of actively going abroad only took off when I was our own Prime Minister. It was logical for PETRONAS to go abroad – reserves were small and, according to the experts, would be exhausted after 20 years. To secure future supplies, we needed to have concessions and produce oil in foreign countries. Unless we went abroad, all our acquired expertise would be wasted once our own reserves were finished.” (Mahathir 2011, p. 650).

Carigali took participating interest in projects led by other oil companies, and also went out to prospect for oil with their own team of geologists and engineers in countries like Sudan, Chad, and Vietnam. By the end of 2015, Petronas operated more than 250 platforms internationally (355 in

¹²⁰ In 1997 Petronas created its own university, Universiti Teknologi Petronas (UTP), a private institution which offers engineering, science and technology programs. Over 14,000 students have graduated from UTP since its creation (UTP 2017).

¹²¹ Since 1980 Malaysia adopted a National Depletion Policy in order to maximize resource recovery, reduce natural gas flaring and extend the life of its producing fields (Bowie 2001, p. 198). This conservationist approach was counter to the interest of foreign oil companies at the time, which criticized it (Gale 1981a).

Malaysia) and had upstream presence in 25 countries, from exploration to production¹²², as well as downstream presence in even more countries selling lubricants, oil, and petrochemicals (Petronas 2016). In December of 2016, Malaysia's NOC successfully bid to explore two blocks in Mexico's first deepwater auction, marking its entry into a market that was closed since 1938. Its international expansion was helped by financing its operation with retained earnings, showing restraint from the part of the executive in appropriating oil rents.

The same organization still hosts a regulatory unit, which is carried through a division called Malaysia Petroleum Management (MPM), and has stakes in a range of subsidiaries – 89 wholly-owned and 38 with a majority-stake – that operates its upstream and downstream businesses across the world. MPM's mission is to attract investments and maximize Malaysia's resource recovery and one of its function is to revise government take to entice investors.

4.5. Adjusting government take and promoting more investments

Over time the fiscal system of Malaysia moved even more towards a model that creates incentives for investment and reduced rent capture in order to build reserves, turn gas discoveries into commercial assets, and produce oil from marginal fields. Since the first 1976 PSC contracts, Petronas adopted five other contractual arrangements; the first in 1985 and the most recent one in 2010. Unlike other resource-rich countries that swing between forced renegotiations (or expropriations) in times of high oil prices and more attractive conditions when the domestic industry is failing, Malaysia shows a stable pattern of contractual arrangement that over time has been "sweetening terms for IOCs seeking to explore oil and gas domestically" (Lopez 2012, p. 818). The NOC also developed, over the years, a relationship of trust with investors, speeding up investments. As Kevin Robinson, vice-president of a multinational private oil operator explains, companies are willing to start investing even before receiving final approvals:

"Business in Malaysia is more based on trust and building a relationship with Petronas. Typically, if you come here as a new company, Petronas would research your background and then decide whether they want you to be part of the business environment in Malaysia. Once you are part of the business environment, a lot of it is based on trust going forward. Some deals we have done, or some developments

¹²² Petronas had upstream operations in the following countries: Algeria, Angola, Argentina, Australia, Azerbaijan, Brunei, Cameroon, Canada, Chad, China, Egypt, Gabon, Indonesia, Iraq, Ireland, Mauritania, Mozambique, Myanmar, South Sudan, Sudan, Suriname, Thailand, Turkmenistan, United Kingdom, Vietnam.

we have done, we might not have all the approvals we needed in time, but we have gone ahead and done it because is based on trust. We have accepted their word and moved ahead... If you are in an American system you probably wouldn't do that. You would wait for the letter." (Interview Robinson 2016).

With the exception of a risk service contract adopted in 2010 specific for marginal fields, all other contractual arrangements repeat the formula of profit-sharing.¹²³ The main differences are that signature and production bonuses, which were already low, were abolished in the mid-1990s and cost recovery increased (from 50% to 75% for deepwater, for instance)(Johnston 2003). The profit oil split was also changed to favor investing partners (from a fixed 70:30 to starting at 50:50) and the government take increases depending on the total production, according to pre-determined rules (a progressive fiscal system). Marginal fields also have more generous tax breaks, such as a reduced tax rate (from 38% to 25%) and accelerated capital allowances.

Given that the main terms of the contract are fixed, Petronas assigns exploratory blocks in closed bids where the main variable is the work program offered by oil companies: the amount they commit to invest in exploration efforts to find new resources. This includes investing in new seismic acquisition and analysis and drilling exploratory wells. Through this formula, companies compete on how much they are willing to invest in increasing the knowledge of Malaysia's geology rather than who is willing to pay a higher signature bonus or a larger share of production to the government. A consequence of this bidding strategy is that it benefits the industrial production chain, such as the service and good providers, all of them operating under a Petronas license and with bumiputera capital requirements. Incentives to explore and develop are needed because Malaysia has no low-hanging fruits for the oil industry: all new reserve additions have been from high-cost resources, such as deepwater fields, marginal and stranded fields previously uneconomical to develop (but potentially viable under new technologies), and the application of improved oil recovery (IOR) methods in fields under production (BMI Research 2016, p.12). By the end of 2015, there were 101 active PSC contracts in Malaysia (Petronas 2016). The fiscal take from these contracts has been important for the public budget, but the Malaysian government also benefits from the dividends of Petronas' operations in other markets. Since its inception, Petronas has contributed with RM934 billion to the Federal and state

¹²³ The fiscal regimes adopted in Malaysia after the creation of Petronas are the 1976 PSC, the 1985 PSC, the 1993 Deepwater PSC (for water depths between 200m to 1000m), the 1993 Ultra-Deepwater PSC (over 1000m), the 1998 Risk over Cost (R/C) PSC and the 2010 Risk Service Contract (RSC). See Mas'Ud et al. (2014) for a full comparison.

governments – more than US\$230 billion – in addition to RM238 billion of revenue forgone with government-mandated gasoline subsidies (Petronas 2016). Of the total revenues that the Malaysian state receives from the O&G sector, since the 1990s from 30% to 40% is accrued in the form of dividends from Petronas (Lee 2013).

4.6. Assessing the limits of the geologically-based incentives and alternative hypotheses

In mechanism-based explanations, it is crucial to assess the evidence gathered and its fit with the proposed theory against alternative hypotheses, as there can be more than one path to an outcome (equifinality) and because “explanations are more convincing to the extent that the evidence is inconsistent with alternative explanations” (Bennett and Checkel 2015, p. 23). This subsection evaluates the limits of the explanation advanced in this chapter and assesses the plausibility of potential competing hypotheses.

Summarizing the case and its explanation, the theory proposed in this chapter is that Malaysia’s rules of distribution of the oil sector, which successfully attracted investors, developed a local supply base and resulted in the build-up of capabilities in Petronas, are not derivative of national level institutions that constrain the executive, ensure transparency, provide credible commitment for investors against expropriations, and secure proper utilization of oil resources. This is not a controversial point since Malaysia has been recognized as a successful case of resource management, but it departs so much from best-practices that can hardly serve as a model for other countries when designing oil-related reforms.¹²⁴ The main contribution of this work is to situate the case within a broader theoretical framework that connects geological endowments with political incentives, and empirically tests it through process-tracing. Additional inferential traction is gained by the structured, focused comparison with Brazil and Mexico which provides further evidence in favor of the hypothesis advanced here on how cost of production influences demands for contracts in the supply chain and the fiscal take by the state. More specifically to the Malaysian case, the evidence collected shows that a reputational restraint mechanism substitutes for formal institutions. Such a mechanism, while long recognized as a way to reduce uncertainty and facilitate exchange (Greif 1993, North 1990, V. Smith 1998), is costly to establish

¹²⁴ For instance, Mexican policymakers, in preparation for the 2013 Energy Reform, studied the Malaysian framework and the possibility of having Pemex function like Petronas, awarding exploratory blocks and regulating the O&G sector. However, this solution was rejected due to the lack of transparency that would undermine the credibility of the reform and grant an arbitrary power to Pemex (interview Melgar 2016).

and may be more fragile to sustain. Nothing but self-interest prevents one of the parts from renegeing on previous deals.

Petronas has not been totally impermeable to political influence as can be seen by episodes of investment decisions following political criteria, the use of the company's cash to bailout failing firms, and the promotion of pet investments. Petronas' first refinery, a small (40 kbpd) facility in Kertih, in the oil-producing state of Terengganu, had its location decided politically by Malaysia's third Prime Minister, Tun Hussein Onn, overruling the technical recommendations of the company to put it in the West Coast, closer to Kuala Lumpur (Hashim 2004).¹²⁵ Malaysia's fourth prime minister, Mahathir Mohamad, governed through a period of great expansion of the company but also clashed with its administration when he used Petronas as a lender of last resort. Petronas injected money in 1984 (US\$1 billion) and again in 1989 (US\$400 million) in Bank Bumiputra to save the public financial institution from collapse. Petronas also played the role of financial savior of the shipping company Konsortium Parkapalan (in 1997), and the carmaker Proton (in 2000), all closely connected to Mahathir (Bowie 2001, Gomez and Jomo 1997, Lopez 2012).¹²⁶ With time, Petronas sold these shares and the interventions did not affect the company's core business as an oil operator or practices as an oil regulator. These episodes show that Malaysia's NOC is not characterized by an absolute absence of political intervention. However, it has been historically low and peripheral given the unconstrained power of the prime minister to issue directives to the company. This incentive-based reputation mechanism could prove to be fragile if political threats raise the returns of short-term survival tactics for the ruling coalition or a large, low-cost discovery reduces the need for meritocratic and efficient management.

Alternative explanations to the development of the resource sector in Malaysia emphasize variation on state capacity and the role of political competition.¹²⁷ One line refers to broad, national-

¹²⁵ Generally speaking, refineries tend to be located closer to consuming centers as it is more economical to transport crude than products. UMNO had a weak position in Terengganu, a state previously governed by PAS in 1956 and again in 1999 (Razali 2014), and Hussein Onn decided to put the refinery there to help support his party bid in the state elections (interview Hashim 2016).

¹²⁶ Mahathir also played a leading role in making Petronas a partner in the redevelopment of Kuala Lumpur's downtown and in the construction of the twin towers headquarters. In a demonstration of the power of the prime minister, the height of the building was changed to fit the well-known Mahathir's proclivity for breaking world records (Wain 2012). "I casually mentioned to Petronas Chairman Tan Sri Azizan Zainul Abidin that since our buildings were only 10 stories shorter than the Sears Tower in Chicago in the US, why not make them taller? Without my knowledge, he then instructed Pelli [the building's architect] to add a few more floors and top the building with spires, which would be included in the towers' overall height." (Mahathir 2011, p. 642).

¹²⁷ For alternative hypotheses, I centered on works that directly dealt with governance of the oil industry (Barma et al. 2012, Thurber et al. 2011, Yusof 2011) or provided explanations that could be applicable to this issue (Slater 2010). Other works address how Malaysia managed to diversify its economy out of primary commodities and

level state capacity that originated from elite coalition as key to avoid the resource-curse, while the other will point out that under weak capacity or authoritarianism with low political competition, the combination of all functions (commercial, policy, and regulatory) in one organization yields better outcomes.

Slater's (2010) analysis of state building in seven South Asian countries represents an alternative explanation from the strand of Malaysia as a state with "strong" capacity. In his study, Malaysia and Singapore are referred to as cases of strong capacity, derived from a history of contentious politics. The mechanism he advances is that, under existential threat (such as communist insurgency and ethnic riots), the elite is more likely to coalesce into a protection pact that helps to build state capacity, such as the ability to extract taxes from the society and manage it through capable bureaucracies, and develop strong ruling parties. However, within Malaysia, the levels of success of state companies – and industrial policy interventions – vary widely. Malaysian state companies are commonly referred to as sources of patronage, cronyism, and corruption (Gale 1981b, Gomez 2002) and policy interventions tend to benefit well-connected entrepreneurs (Fraser et al. 2006, Johnson and Mitton 2003). Companies that received heavy support of the state, such as the national car project Proton (Wad and Govindaraju 2011), have failed to conquer external markets or even sustain themselves domestically without subsidies and renewed government bailouts. National-level state capacity, thus, fails to account for the high variation within Malaysian state firms. Furthermore, it is still puzzling that the country's state company with the best reputation of an efficient and clean management would come precisely from the oil sector.

An opposite explanation has been advanced by Barma et al. (2012). In countries with low levels of human capacity and technical knowledge of the oil industry, they claim that it may be better to consolidate commercial, policy, and regulatory functions in the same organization. In addition to Malaysia, Barma et al. (2012) cites Angola and Venezuela as examples of this mechanism (Barma et al. 2012, p. 93). If the explanation derived from Slater's analysis fails because it assumes a strong state capacity across the board, the problem with Barma et al. (2012) hypothesis is the opposite, which is to assume that the model depends on being an island of excellence surrounded by a weak state – while in reality Malaysia is more like a mid-institutional level country like Brazil and Mexico. Furthermore, the collapse of PDVSA during the Chávez and Maduro governments, with declining production and capacity to pay its service contractors, makes it a poor comparison to Petronas.

industrialize, escaping one of the problems of the resource curse. For explanations on this latter aspect, see Abidin 2001 and Noh 2014.

Thurber et al. (2011) study the diffusion and results of the “Norwegian Model” of oil governance: the separation of functions of the natural resource sector by distinct and independent government bodies. Malaysia is considered to be an archetype of a high performer despite not following the international best practices that originated in Norway. The authors attribute such performance to the lack of political competition that prevailed under Mahathir’s tenure. For the post-Mahathir period, when Malaysian politics became more pluralistic and opposition parties made important inroads, they are more pessimistic of the resilience of such arrangement and suggest to separate functions like the Norwegian model. However, the fact that Petronas’ performance did not suffer from Mahathir’s departure, as they feared, shows a robustness of the existing arrangement that is not explained by them. Moreover, it is not clear why an unconstrained authoritarian ruler, short of an unchallenged king or dictator for life (situations which do not apply to Malaysia) would refrain from intervening in a country’s oil company.

Finally, Yusof (2011) makes an argument that blends the state capacity and political insulation hypotheses. He credits the success of Petronas to the “capability and integrity of the senior management” (Yusof 2011, p. 206) since its early days, working in an organization incorporated as a company and not as a bureau, and protected from populist pressures by its direct link with the prime-minister rather than the parliament. These are all likely true, but most proximate factors and not root causes. The selection of the management team is not exogenous: it is a direct product of the strategic choice of the various prime-ministers over time, as it has been their decision to refrain from interventions that could steer the company away from its core mission. Therefore, it is possible to conclude that existing explanations do not fully account for the Malaysian case. A geological endowment perspective and the incentive-structure that it creates provides far more explanatory power.

5. Conclusion

In 1974, when policymakers of Malaysia created Petronas and opened contract renegotiations with IOCs, they wanted to secure the highest government take possible, mirroring the experience of other oil-rich OPEC countries, like Saudi Arabia. However, their geological endowments were not nearly as attractive as Middle Eastern fields: Malaysia had high-cost offshore reserves, of limited volumes, mostly of gas. IOCs signaled strongly that they could just walk away and refrain from investing in Malaysia, and negotiators from the part of the government had to adjust the fiscal terms accordingly.

Notwithstanding, the high-cost of production and intense outsourcing of the industry represented an opportunity to use the oil sector to fulfill the inter-ethnic redistribution of the NEP through business contracts, helping UMNO's Malay constituency. Oil companies and the government worked out a compromise on the rules of distribution of the sector that, despite the institutional fragility of Petronas on paper, showed to be remarkably stable over time. In sum, since the creation of Petronas in 1974, Malaysia's rules of distribution prioritized partnerships with IOCs, a strong local content, and a decreasing government take.

Petronas' mission statement is composed of four components: 1) We are a business entity; 2) Oil and Gas is our core business; 3) We add value to this resource; 4) We contribute to the wellbeing of society (Petronas 2016). Mission statements can reflect empty words, aspirations and/or practices. In the case of Petronas, it captures the practices of a company that indeed has functioned as a business entity at the same time that it promoted broader societal goals, such as a bumiputera supply chain. It did so while defying standard policy prescriptions on the governance of the oil sector. Malaysia stands at odds with the recommendations of how to handle the O&G sector by combining policy, regulatory and operation in the same organization, with minimal information disclosure, and having a NOC not accountable to any regulator or parliament committee but only to the prime-minister, who has legal unlimited authority to issue directives to the company. Despite that fragile institutional basis, *e pur si muove*.

Petronas' track record of a capable regulator, operator, and promoter of a domestic supply chain has been praised by specialists (e.g. Stiglitz 2007, Collier and Venables 2011) and the company has successfully expanded overseas, having a quarter of its reserves outside of its home market. However, when Malaysia's resource sector is compared internationally on the basis of its formal rules it ranks poorly. The country receives a classification of "weak" in the Resource Governance Index, occupying the 32nd position out of 58 countries measured (RGI 2013). Its budget practices are opaque, standing on the 49th position out of 102 countries in the Open Budget Index (International Budget Partnership 2015) – a poor showing in an indicator previously used in resource-curse studies (see Ross 2012). These outcomes are puzzling to standard resource-curse accounts but can be explained by a theoretical framework that highlights the role that geological endowments and extraction costs play on the rules of distribution and governance of the resource sector, as developed in Chapter 2 and summarized here.

After a brief incursion on Malaysia's history of ethnic tensions and distributive demands, this chapter proceeded through process-tracing, showing the intermediate steps that connect Malaysia's

geological constraints to the rules that govern Malaysia's oil industry and Petronas' emphasis in building capabilities, promote a local supply base (of bumiputera ownership) and expand internationally. It showed how geological endowment and cost of production influenced the way policymakers created the regulations of the oil sector in 1974, adapted tax regimes over time to fit its relatively poorer and costlier resources, and exploited high development costs to build a Malay commercial class through supply contracts. The constraint that is born out of a geological endowment, mediated by the political process, showed to influence the rules and practices of the natural resource sector, representing a novel type of oil politics. In short, the explanation advanced in this chapter is of a reputational restraint rooted on geological constraint.

Malaysia, thus, partially departed from the path chosen by Brazil and Mexico (after the 2014 reform), which responded to geological challenges by institutionalizing rules to attract private investors and placing their NOCs under control of independent regulatory agencies and other formal constraints. Like Pemex for the Mexican state, Petronas has been an important source of fiscal revenues for the public budget, occasionally making it as high as in Mexico with about 40% of the total public revenues (Lee 2013). However, about 30% to 40% of all hydrocarbon income enjoyed by Malaysia, since the 1990s, is accrued in the form of dividends paid by a lucrative Petronas, while Pemex rarely had a positive bottom-line (see Chapter 3). Like the cases of high-cost oil (Brazil and Mexico after 2014), the supply chain has also been subject to strong distributive pressures in the form of local content mandates. In the Malaysian case, local content development has served to build a Malay commercial class through stringent ownership and employment requirements, benefitting the constituency of the party in power, UMNO. These objectives have been codified in Petronas' procurement rules, which separates O&G activities in close to 900 standardized codes in order to maximize what can be done locally.

Chapter 7:

Conclusion

1. Rethinking the role of extractives in the process of development

The role of extractives, and the oil industry in particular, has occupied an odd place in development policy, particularly after the rise of the resource curse literature from the mid-1990s onwards. If economic development is about structural change and moving towards more complex activities that embed more knowledge, as posited by Amsdem (2001), Rodrik (2007) and others, digging oil out of the ground has been viewed as an activity least likely to promote knowledge-intensive industries that generate spillovers to the economy. Quite the opposite, oil exports can exacerbate Dutch Disease effects, displacing industries which benefits from learning-by-doing effects by one (supposedly) without such positive spillovers (Sachs and Warner 1997). Politically, a ruling elite with access to plentiful oil rents is more likely to enrich itself and repress opposition (Cuaresma et al. 2010, Ross 2012), as well as adopt growth-retarding policies that inhibit innovation (Acemoglu and Robinson 2012, Robinson et al. 2006).

Standard diversification strategies for resource-rich countries (e.g., Gillis et al. 1992, Hirschman 1958, Prebisch 1950) involve a combination of developing industries that use the abundant natural resource as a raw material (downstream development) or using rents from the primary industry to nurture unrelated sectors (fiscal linkages). The assumptions of these strategies are that the oil industry is “low tech” and has low capacity for backward linkages, job creation and transferring skills, but can serve as a source of raw materials and funds for other economic sectors. In other words, transformative development *beyond* the oil industry is supposed to occur with funds and raw materials *from* the oil industry but not with technological contributions developed *within* such industry.

Interestingly, that was not how Norway has chosen to manage its oil wealth. The poster child of the narrative that oil is not necessarily a curse, Norway has actively promoted the growth of a supply chain sector and a network of research centers linked to its natural resource industry. It transformed black gold into “grey matter” through scientists based at Norwegian universities and workers at supply companies. They, in turn, helped the country to find and develop new oil reserves and maximize the recovery rate of its existing assets (Hatakenaka 2006, Ryggvik 2014, Ville and Wicken 2012). Furthermore, Norway’s oil capabilities were not advanced by using crude oil to build refineries and petrochemical plants – downstream development. Norwegian involvement in the downstream is

marginal: Statoil, Norway's National Oil Company (NOC), is a technology-focused upstream energy company, which seeks to reduce their cost of offshore oil production and carbon-intensity (Statoil 2017). Through active government involvement and not necessarily by transparent means, the Norwegian state promoted technology transfer from International Oil Companies (IOCs) to local suppliers, building a domestic offshore oil industry. Rather than impartial rules, as Kolstad and Wiig (2009) recommends to oil-rich countries, Norway signaled strongly to IOCs that using local suppliers would benefit them in their biddings for exploratory acreage in the Norwegian Continental Shelf. As Nordas et al. (2003, p.65) write: "...the oil companies never doubted that the Norwegian government and politicians appreciated the choice of local firms to supply the oil and gas activities with goods and services, and they were pretty sure that this would be honored in negotiations for future licenses. Thus, during the late 1970s and early 1980s local firms probably were chosen even if they were not the most cost effective." The Norwegian state used its bargaining power over exploratory areas and the purchase capacity of Statoil to promote a supply chain that, by 2009, was responsible for 29% of the revenues obtained from the non-oil exports of the country (Ryggvik 2014, p. 195).

Norway's industrial policy for the O&G industry has received far less attention in the resource curse literature than the country's institutional foundation and sovereign fund (Segal 2012, Stiglitz 2007, Thurber et al. 2011). This absence exists, at least in part, because the resource curse literature is focused on rent capture and management, under the belief, as Segal (2012, p. 340) puts it, that "resource rents are the closest we have to manna from heaven." This common view is oblivious to the fact that in the natural resource industry there can also be a process of rent creation, particularly when geological challenges need to be overcome, a situation which has political and economic consequences.

This dissertation has focused on this often neglected side of the oil industry: the rent-creation and distribution processes that exists in the upstream when geological challenges are present and cost of production is high. Geology is seen both as an opportunity for industrial policy, understood as "government policies directed at affecting the economic structure of the economy" (Stiglitz et al. 2014, p. 1), and as a tool for wealth redistribution through contracts and job opportunities. High-cost of production implies that oil wealth will mean much more than just the rents from barrels sold. Contracts in the supply chain, or what it takes to output barrels, becomes politically important too and actively sought by businesses and workers representatives. Together with the executive branch of government and oil companies, local businesses and workers bargain for a share of the oil wealth in the form of contracts. As sources of "easy oil" deplete and production from unconventional sources grows, it

becomes increasingly relevant, from a theoretical and policy perspective, to understand how changes in resource endowments and industry structure affect the politics of oil abundance.

As shown in this work, extraction costs generate a different set of incentives to the stakeholders of the oil industry. Governments that want to maximize rents and production growth will have reasons to avoid industrial policies of local content (hereafter, LC) requirements, as they impose extra costs in the short-run and can result in production delays. However, extraction costs also affect interest groups (such as industry associations and workers' unions) by shaping their distributive demands and expectations about future costs from the extractive activity and potential benefits. Local industrialists and workers will understandably want to be the ones responsible for supplying the steel, platforms, drilling rigs and all sorts of equipment and services involved in the high-cost O&G production – pushing for LC requirements. The distributive rules of the sector will be the result of a winning coalition that arises from the bargaining between the interest of the executive, parties, and pressures from interest groups. If the rules tilt too much for redistribution in the form of contracts, such as high LC targets in a domestic productive sector that lacks domestic capabilities, it risks leaving all oil in the ground, given prohibitive costs. Likewise, if taxation is set too high for a resource that has a high cost of production, investments will be discouraged. Therefore, key political battles are fought, for unconventional oil, in the rules of distribution of the sector that defines who can extract, under what tax regime, and subject to what type of procurement rules.

The abundance of unconventional oil opens up new policy spaces and areas of study of the politics of oil-rich countries. In particular, it calls for a better comprehension of the industrial and innovation policy opportunities and constraints in the contemporary economy in an industry that is highly modular and globalized, but where nation states still hold much power that derives from sovereign ownership of subsoil rights. Those who control the access to oil on the ground have much influence in shaping the rules under which extraction will take place (Mommer 2002). Such power is not limitless, but far exceeds industries where the barriers of entry are not as high as in O&G – which can only be produced in nations with resource endowments to begin with. The oil industry is considered to be special in economic terms because firms can have radically different cost structures, such as 20 times more than a competitor (think Saudi Arabia's conventional fields versus US shale or Brazil's deep offshore reservoirs), and still compete in the same market (Pinto Júnior et al. 2007). Access to reserves is the explanatory factor of how such wide disparities of margin can occur.

This concluding chapter reviews and compares the main findings of the three case studies, suggests areas for further research and addresses policy implications.

2. Findings

The empirical chapters of this dissertation address the development of the distributive rules of the oil industry in Mexico, Brazil, and Malaysia: the role played by private oil companies, the evolution of the government take, and localization policies (R&D and manufacturing). Together, they determine how societies manage their oil wealth in terms of capture, distribution, and creation. All three cases have in common their GDP per capita levels (classified currently as upper middle income by the World Bank) and the presence of SOEs that play a pivotal role in the oil sector. However, while Mexico has been endowed with easily accessible, low-cost oil, Brazil and Malaysia had to develop capabilities to exploit their more challenging offshore reservoirs.

Mexico has largely followed the resource curse paradigm in the way it has developed its oil industry, particularly after the discovery of the Cantarell oilfield in 1977. Despite having expropriated the oil industry in 1938 with the creation of Pemex, a government monopoly, it was only after the discovery of Cantarell that the Mexican state became a *petrostate* in its reliance on oil revenues for the public budget. Cantarell is a naturally fractured carbonate reservoir, resulting in a prolific production with low cost, which could be quickly developed using foreign technology and suppliers, as it was. Production from Cantarell resulted in an increase of the dependence on oil rents to the public budget from 20%, in 1977, to 49.8%, in 1983. The decision to develop the Cantarell complex at full speed maximized oil rents over other activities that could have generated spillovers along the oil production chain. The Mexican state has continued to be addicted to oil rents and kept a high government take on Pemex's activities despite the diversification of its economy, which occurred in the 1990s and 2000s.

Starting in 2004, the use of Pemex as the state's cash cow was in peril: Cantarell's easy rents had its days counted as the field reached its peak production. In the following years, additional output from Cantarell would be lower (in volume) and more expensive, increasing the unit cost per barrel from \$5.24 in 2006 to \$28 in 2014. Pemex also failed to compensate for the decline of Cantarell's output with new discoveries, and the result was a drain in the country's total reserves. Mexico had plenty of potential unconventional resources, such as deep offshore in the Gulf of Mexico and tight oil in Chicontepec. However, the country's monopoly regime and high taxation prohibited Pemex from sharing the burden

of high-capital investments with other private companies, as is the standard in the industry in high-risk, high-cost projects, and discouraged investments in unconventional resources as they were taxed as highly as conventional fields.

Mexico's constitutional energy reform, initiated in 2013 by the president Enrique Peña Nieto, was driven by the exhaustion of a rent-capture model that was effective in taxing and distributing rents from low-cost and technically easy-to-produce resources but proved to be incompatible with the development of high-cost areas. The initiative was a direct reaction to new geological challenges that gave the executive an incentive to modify the rules of the sector since it is both directly responsible for production and the first branch of government to bear the loss and be held accountable for declining oil revenues. What once was thought to be impossible, a profound reform that ended Pemex's monopoly, was approved when the PRI administration abandoned its key political ally in the sector and the group most invested in the old institutional arrangement: Pemex's union and its legislative supporters. In their place, the PRI built a coalition with the PAN where the imposition of a LC mandate was a key factor in gaining the support of "nationalists" and representatives of business associations. Lawmakers also passed a fiscal reform that is projected to increase the general tax burden of the economy by 2.5% of the GDP, reducing the dependency on oil rents.

The Mexican case shows how a changing resource-base induces different incentives for the stakeholders of the oil industry, which ultimately led to a profound revision of the rules of the sector. Theoretically, the case casts doubt on accounts that claim a strong path-dependency of the rules of the resource sector. The changes in Mexico highlight the role of agency and the opportunities for coalition-building, proving that countries are not trapped by their institutional arrangement.

In contrast to Mexico, the Brazilian government built its oil industry through a heavy investment in domestic capabilities in manufacturing, R&D, and human resources. The effort was led by its NOC, Petrobras, which was created in 1953 with the mission to find and develop O&G resources in an oil-poor country. After failed exploratory campaigns on onshore basins, Petrobras made the strategic decision to invest in offshore oil exploration since the late 1960s. In the 1970s, discoveries in the Campos basin, off the coast of Rio de Janeiro, proved that Brazil had potential for offshore oil production, particularly in deep waters, but extraction would be neither easy nor cheap. To overcome geological challenges, Petrobras invested heavily in its R&D center (Cenpes) and developed strong ties with Brazilian universities, in special the Federal University of Rio de Janeiro (UFRJ). Already in 1984 Petrobras was producing oil from deep offshore fields and soon would become a world leader in this segment.

Despite the technological capabilities of its NOC, Brazil was still importing about 60% of its oil consumption by the mid-1990s. Petrobras' monopoly hindered the development of the sector because the high-cost and high-risk exploratory programs in deep offshore waters could not be shared with partners. The government of President Fernando Henrique Cardoso (1995-2002) sponsored the opening of Brazil's oil industry through competitive bidding rounds open to any qualified oil company, starting in 1999. Rather than shrink, Petrobras had impressive growth after the market opened. The company's longstanding investment program in deep offshore capabilities and intimate knowledge of Brazil's geology gave the NOC a natural advantage in open bids. Private competitors frequently preferred to associate with Petrobras rather than try to outbid it during oil auctions.

In the process of drafting the rules of the market opening, business associations and representatives of workers lobbied for regulations that would benefit local sourcing. What Petrobras used to do by itself – invest in R&D in Brazil and in developing suppliers – was institutionalized in formal rules in the form of LC policies and earmarked R&D resources, obligations that private companies would also have to follow. Therefore, since the first bidding round in 1999, LC requirements have been part of Brazil's oil distributive rules. However, the weight of LC in the process of gaining access to exploratory areas increased over the years in response to political pressures by business associations and a stronger industrial policy activism by the executive, which was under the Worker's Party (PT) government between 2003-2016. The PT has a strong constituency in labor unions, which stood to gain from the expansion of metal mechanic activities in the O&G supply chain. With the discovery of the large pre-salt reservoirs, in 2007, LC was put to the forefront, and the country's domestic industrial capacity was put in law as a criterion to determine the pace of new bidding rounds (Article 9, Section 1, Law 12.351/10).

With investments that had reached up to \$40 billion per year, Petrobras was at the center of Brazilian politics during the last 15 years given its technical achievements and a strong investment program that generated thousands of jobs in the supply chain and in new refineries and petrochemical plants throughout the country. However, Brazil's leading company had its image tarnished in 2014, when a Federal Police operation revealed a large corruption scheme that involved career employees, contractors, and politicians. The scheme started in 2004 and gained momentum as the investment budget of the company increased, with contractors paying from 1% to 3% as kickbacks, spreading to Petrobras corrupt practices that were common in other Brazilian SOEs and public agencies. However, as shown in Chapter 5, the problems of Petrobras went much beyond the direct cost of bribes and also included politically determined gasoline prices and investments in the downstream sector.

In hindsight, Petrobras was among the least likely NOCs to fall prey to political meddling and widespread corruption. First, it has an above-average governance structure for an NOC, with shares listed on multiple stock exchanges (including in the United States) and a board that includes independent members, as well as auditing and transparency requirements equal to those of publicly listed companies (Musacchio and Lazzarini 2014, Tordo et al. 2011). Its shares were spread among many investors, including Brazilian workers who used their savings accounts (FGTS) to buy shares of the company. Such broad ownership would be expected to create constituencies to monitor the performance of the company and defend it against political predation (Shleifer and Vishny 1998).

The Brazil case shows heterogeneity, where the oil sector has been a major contributor to scientific and manufacturing capacity but also an instrument for illegal political gains to a ruling coalition. It is important to note that innovation preceded corruption, and only after production and reserves were multiplied, by the mid-2000s, did the oil surplus attract rent-seeking behavior by political parties, suppliers and its own employees. The evidence corroborates the argument that the driving force behind Petrobras' success as an NOC was the context in which it operated, its geological challenge that propelled the company to invest in capabilities. Therefore, it was not a result of national level institutions that supposedly would have constrained political meddling. Furthermore, the company still plays a leading role in Brazil's national innovation system and can be spared from party corruption, as it had been before, if internal promotions and investment goals are shielded from political influence, which is frequently a challenge for emerging and young democracies. The demonstration effect of having contractors, politicians, and former executives jailed is also likely to reduce the temptation to divert resources for corruption in Brazil.

Of all the cases, Brazil had the strongest institutions, on paper, but the incentives in the political system changed from protecting the company from the coalition-building game to rent-seeking once investment capacity and production increased. Malaysia, on the other hand, has the weakest institutions on paper but the political incentives are to avoid interfering with Petronas, its NOC, in order to sustain investment levels given the country's small domestic reserves and the necessity to keep its efficiency and capital discipline to expand overseas.

Since its creation in 1974, Petronas had to follow a dual mandate: to serve both as the custodian of Malaysia's O&G resources with a mission to maximize the commercial benefits of their exploitation and as a vehicle for the development of the nation. The latter mission includes the promotion of ethnic Malay businesses and workers according to politically controversial quotas that originated from

Malaysia's tense ethnic history and the country's leading political party, the United Malays National Organisation (UMNO), key political agenda. Although it deviates from the "best practices" manuals by not separating policymaking, regulatory and operational functions of the oil sector; by not being formally protected from political interference; and by pursuing ethnic distributive goals as part of its operations, it is a highly profitable company, with a quarter of its reserves outside its domestic market, with an aggressive investment plan in technology-intensive assets and widely regarded as professionally run (Stiglitz 2007, Slater 2010, Marcel 2006).

Petronas benefited from operating in a competitive domestic environment where it could learn from partners – a direct result of the geological constraint that marked its creation. Malaysia did not expropriate its O&G resources and managed them by a monopoly, in the 1970s, in part because it lacked the capital and human resources to takeover offshore operations and find new reserves. Instead, it sought mutually beneficial deals with IOCs such as Shell and Exxon. Yet, through stringent contractual terms, it ensured the transfer of technologies, the training of nationals to replace expatriates, and the growth of an indigenous supply chain. The realization of a limited geological endowment in the 1970s, one where reserves would last for about 15 years, led Petronas' executives to design policies to use the oil wealth as a window of opportunity to develop a supply chain sector that could outlive the limited domestic endowment and create jobs for the bumiputera – the indigenous ethnic groups and UMNO's constituency. With a continuous flow of investments, reserves continued to grow. But in order to attract and sustain the interest of oil companies to produce in a country of increasingly complex and high-cost oil and gas fields, Petronas never reneged on its contract and has reduced government take over the years in new bidding rounds. It has developed trust with investors to compensate for the lack of "ideal" institutions.

Malaysia, thus, developed its oil industry with the heavy presence of IOCs, but under strict rules that guided the allocation of oil wealth to build domestic capabilities. At the beginning of its oil development in the late 1960s, Malaysia was short of industrial capacity and human resources, in a mostly laissez-faire economy, exporting basic primary products such as rubber and palm oil (Jomo 1999). Malaysia's success challenges both standard accounts that link the development of the oil sector to good national level institutions at the time of discovery (e.g., Karl 1997, Ross 2012) and as developmentalist explanations that emphasize the role of pre-existing human capital availability and a legacy of import-substitution industrialization as key factors to make oil wealth contribute to growth (Kurtz and Brook 2011, Brooks and Kurtz 2016).

Table 7.1 presents a summary of the cases across key time periods. Both Brazil and Mexico are analyzed over two periods. Malaysia is the case with the least change in the rules of the sector since the creation of Petronas in 1974, because the only significant difference has been a decrease over time of the government take to create incentives for investments in the country's (increasingly costly) resources. The patterns that emerge are that Brazil and Malaysia shows a continuity of medium to high costs of production and LC development efforts, while this issue only became an obligation in Mexico in the 2013 energy reform. All three cases also show convergence to the participation of private companies in their upstream sector, a key factor to stimulate investments in high-cost resources by sharing geological risks, capital costs, and bringing together different expertise.

Table 7.1: Cost of production and rules of distribution

Cases	Cost of production	Private sector participation	Government take	Local content
Brazil (1954-1994)	Medium	None, government monopoly	Very low	Petrobras's own supplier development programs
Brazil (1997+)*	High	Through competitive open bidding rounds	Low	Formal, specified in contract
Mexico (1938-20012)	Low	None, government monopoly	High	None
Mexico (2013+)	Medium/High	Through competitive open bidding rounds	Lower, decided by bidding conditions	Formal, specified in contract
Malaysia (1974+)	Medium/High	Through competitive direct negotiations with Petronas	Adjusted to production and resource type; lower over time	Formal, through local licensed vendors; preference for bumiputera-owned companies

* After 2010, government take was raised but only to the pre-salt area

The theoretical model developed in this dissertation, and the findings that come out of the empirical chapters, question the heavy emphasis on formal institutions that is prevalent in the resource curse literature. It does so by revealing the power of political incentives (constraints and opportunities)

that derive from geological factors. This approach contrasts with the mostly negative view of how oil wealth affect the political economy of developing countries, such as that provided by Michael Ross, a leading scholar on the resource curse literature, who writes: “The oil curse is largely caused by the unusual properties of petroleum revenues. Unless countries are already wealthy and have strong institutions at the time that oil production begins – like Norway or Canada – they can cause profound political and economic problems” (Ross 2012, p. 234). This work shows that neither exceptional institutional foundations nor a stock of human resources are prerequisites to convert oil into more than just rents captured by an elite. If barriers are not insurmountable, there is more policy space for productive development, with the localization of manufacturing and R&D in O&G as two major examples. This realization calls for more analysis on how industrial policies in O&G can be designed, implemented, monitored, and corrected to maximize the non-monetary benefits that drive from oil production.

3. Practical implications

3.1. Design of industrial policies in local content

The contemporary O&G industry has a complex structure, with a long value chain, multiple stakeholders, and intense government participation in all aspects, from setting the rules of exploration and production to environmental standards of refined products. Therefore, unlike other economic sectors where the participation of the state is optional and has been retracted during the period of more intense market opening of the 1990s and 2000s, in O&G governments of resource-rich countries are owners of subsoil resources and continuously face a crucial set of decisions, starting with “whether or not explore for petroleum, at what pace to explore, and who should undertake such exploration” (Tordo et al. 2011, p. 2). LC requirements add a new critical issue to that list by specifying how exploration (and production) should be done in terms of the origin of the goods and services used in the activity and, in many cases, the nationality of the workers. And, as production from high-cost resources grow, coupled with a demonstration effect of how other countries address this issue, policymakers will face more pressure to negotiate a higher local participation in their exploration and production contracts with oil companies.

Such effort to localize productive activities brings its own set of challenges. Governments, suppliers, and oil operators need to coordinate investments in a selected scope of activities and skills to

be localized and match their availability with the projected industry demand. This coordination activity involves, first, intense information exchange to identify both the present domestic capabilities and the future demand. Second, it requires balancing policy objectives with distributive pressures.

From an industrial policy perspective, an LC target is a tool to accomplish an economic strategy, not an end in itself. Yet, from a distributive perspective, it might well be an end in itself, such as to create and sustain jobs in the supply chain, regardless of the productivity gaps between local companies and the more established international producers. These two objectives can conflict with each other, with the distributive dimension undermining structural transformation, which is a frequent objective of industrial policy and one that markets do not manage well due to the presence of externalities (Stiglitz et al. 2013, p. 7). However, because oil prices are exogenously determined, excessive inefficiency in the supply chain, by raising costs and lengthening delivery times, will reduce investments in periods of low oil prices. Therefore, the growth of a domestic supply chain, in the long-run, will largely require an effective increase of local capabilities. It is thus important for policymakers and stakeholders to have a clear view of the strategies available, with their opportunity costs and trade-offs, to pick and calibrate the tools to meet the policy objectives. Hence, distributive pressures can drive the adoption of LC requirements, but the success and sustainability of using oil contracts to generate local business opportunities and jobs will depend on the effectiveness of the coordination of investments and upgrading of local capabilities.

In a stylized fashion, there are two ways LC policies can be planned. Both of them require measuring current domestic industrial capacity but they differ on what they plan to achieve in the future. A conservative strategy would start by estimating future demand in order to set a target, but would not aim to go much beyond the current capabilities. Because operators might not know the capabilities available and may prefer to just use their own set of global supply companies, the exercise of estimating the supply capacity can be helpful to reduce information asymmetry between oil operators – which are frequently foreign companies (the IOCs) – and the existing domestic supply industry, benefitting the latter. Furthermore, a study of local capacity and future demand can signal to current local suppliers the future demand of the sector, leading them to pursue incremental investments in their existing plants. This strategy, however, does not aim to structurally change the local supply industry, but rather to optimize its use by reducing spare capacity or promoting investments in the existing sectors. It is the scenario most compatible to a strategy of maximizing hydrocarbon output by not introducing costly bottlenecks and uncertainties. Mexico's original LC policy in the context of the

2013 constitutional energy reform started this way, with LC targets low enough to be achieved. It, however, was changed during the legislative debates because of the pressure towards much higher LC. The compromise solution was to add a gradual increase over the course of 10 years (from 25% to 35% for onshore and shallow water fields), with future revisions.

The alternative strategy available to oil-rich countries pursuing LC policies is to bet on developing new sectors. It measures present capacity to identify what is currently not produced (or skills not available) and sets a policy to expand domestic capabilities. Given an estimated future demand, it promotes sectors that will require investments in new activities in order to fulfill the projected demand. It is a bet because it involves more uncertainty. For the government, this requires strong commitment to the identification and solution of bottlenecks and the development of auxiliary programs that can reduce domestic costs and increase productivity and attract. From the point of view of oil operators, this is a source of uncertainty, as they would be committing themselves, assuming that O&G discoveries are made, to purchase from a capacity which is only promised, where issues like time-to-market, quality, and price are yet unknown. This strategy prioritizes industrial promotion over short-term revenues from O&G production. If successfully implemented, it leads to stronger industrial capacity and scientific knowledge, capturing more wealth from high-cost oil. If poorly implemented, it creates over capacity of uncompetitive firms that will fail to survive during market downturns in the oil sector.

Both strategies rely on estimating future industrial demand, which in the hydrocarbon sector is no trivial issue. The estimate depends on the success rate of the allocation of exploratory areas (e.g., bidding rounds or direct negotiations) and the subsequent success rate of oil companies' exploratory programs. Therefore, in the case of public bidding rounds, a) blocks put to bid are greater than or equal to b) blocks purchased, which are in turn greater than or equal to c) blocks with discoveries. And the effective demand will mostly come from the latter.

The government only fully controls the first step of the process – the selection of the blocks put to bid. Market conditions, which include exogenous factors, such as the price of oil, and endogenous decisions, like the minimum government take, shape the success rate of the bidding rounds. Finally, investments in the exploratory programs and geological factors determine the number of exploratory campaigns that are successful in finding O&G. If enough resources are found and if they are deemed to be commercially viable given current prices and technology, then, and only then, will there be a commercial discovery that is followed by the investments in production.

The above passage highlights the uncertainties involved in exploring and exploiting hydrocarbons, particularly in frontier areas. These uncertainties affect forecasts of demand, thus adding more challenges to a LC strategy.¹²⁸ Another risk faced by oil operators is that domestic industrial capacity at the time of bidding can deviate significantly in comparison to the moment of procuring goods and services, considering that a commercial discovery is made years after the initial bidding round. Particularly for deep offshore oil fields, where from the exploratory phase to development can take close to a decade, this risk becomes highly relevant. Given these issues, Almeida and Martinez-Prieto (2014) recommend flexibility in establishing LC commitments to better reflect the needs of operators (which are only fully specified after the exploratory phase) and the varying domestic market conditions.

Finally, if the combination of risks – geological, regulatory and the costs and uncertainties associated with LC requirements – are considered too high by oil operators, companies may refrain from investing. Therefore, LC is one of the factors that may decrease the investment attractiveness, particularly if set too high and with clauses that establish fines and punishments in case of noncompliance. As Grossman (1981) pointed out, by increasing the total price of a finished good, LC requirements may lower the demand for that particular good, and consequently lower the domestic demand of its suppliers, in comparison to a counterfactual where the contractual content preference is absent. Design of industrial policy for LC in O&G is, thus, a challenging task that deserve further attention as this practice grows.

Policymakers in Brazil and Malaysia used the demand from the oil sector to attract new suppliers and capture a higher share of the value chain. While the broader objective has been the same, the instruments used by policymakers in the two countries differed substantively. The Brazilian government, after the opening of the oil sector, relied on a more legalistic and rigid approach, which evolved to specific national targets set into the upstream contracts down to the component level. The policy is also indifferent to the origin of the capital of the firms – as long as manufacturing is made in Brazil it complies with the LC requirement since there is no legal difference between a Brazilian-owned supplier or a subsidiary of Schlumberger or FMC Technologies, for instance, operating in the country.

¹²⁸ This will be particularly acute at the moment of market opening, such as in the initial bidding rounds of Mexico in 2015. However, uncertainties decrease with time as more rounds occur and the then-frontier geology becomes more studied, thus easier to predict success rate of exploratory programs. In addition, ongoing investments from previously held bidding rounds provide a clearer picture of the needs of oil operators as projects evolve according to their schedule.

The Malaysian government, on the other hand, adopted a more flexible approach, which has no specific target number for LC or third-party companies certifying the nationality of each expenditure, as is done in Brazil. Instead, the policy focuses on the capital ownership of suppliers and the nationality of the workers: all suppliers have to have at least 30% of capital ownership by local ethnic groups, the bumiputera, and multinationals have to set up specific subsidiaries to comply with that requirement. Bumiputera agents serve as brokers of imports and they can be selected by Petronas to enter into a vendor development program to replace imports by local manufacturing. The instruments reflect the legacies of the political economy of the two countries, with Brazil's hierarchical capitalism (Schneider 2013) relying heavily on big business groups and multinationals, and Malaysia's less formalized but pragmatic industrial policy emphasizing inter-ethnic redistribution (Jomo 2007, Hwok-Aun 2007).

3.2. Lessons for conventional oil producers

This research posits that high-cost oil producers can benefit from the higher demand for industrial goods and innovative solutions that take place during the exploration and production of unconventional resources to design industrial and innovation policies that benefit from and support the development of the natural resource sector. This raises the question: what are the implications for conventional oil producers, which enjoy high-rents from the exploitation of their endowment but do not have the same opportunities for industrial and innovation policies in the supply chain?

The first consequence of the growth of supply from unconventional production is that this will put pressure on the political economy of conventional oil producers. The ability of low-cost producers to exploit Ricardian and monopoly rents is limited by the overall growth of the demand for oil and the growth of supply coming from competitors of unconventional oil and their rate of productivity gains (Espinasa 2016). The vast unconventional reserves unlocked by technology and the growing concerns over climate change has switched the conversation from "peak oil" to "peak demand." In the world of peak oil – a concept popularized by the geologist Marion King Hubbert in the 1970s, which was much revived in the 2000s (Inman 2016) – resource-owners sit on a reserve of wealth that the rest of the world desperately seeks and is ill-prepared in the short- to medium-term to live without. In this scenario, half of all oil supply has been produced and additional supply is limited by a physical scarcity, with consumers having to pay increasing sums to purchase the remaining stock of oil. This imagined

situation is likely to lead to a growing transfer of wealth from consumers to producers per barrel of oil traded.

In comparison, in a peak demand scenario, consumption is not limited by physical scarcity, but rather by political and environmental constraints and technological alternatives (for instance, efficiency gains in hydrocarbon consumption and increased availability of renewable fuels, displacing hydrocarbons). In a peak demand scenario, plenty of oil exists in the ground, but these assets can become stranded in a world that prefers to reduce its hydrocarbon consumption or has access to cleaner and cost-competitive alternatives. For example, McGlade and Ekins (2014), based on scenario simulation, estimate that up to 600 billion barrels must remain un-burnable for the world to reach a low-carbon energy system, one that limits the global average temperature rise to 2°C. Because of their large reserves, Middle East nations are the ones with most to lose in the long-run by leaving un-burnable reserves.

The more competitive unconventional producers become, more market they can displace from traditional producers. Therefore, the first lesson to be learned for conventional oil producers is that innovation rents will pressure the political economy arrangement that they have in place. In fact, the rise of unconventional oil production from the US is already exerting such pressure. It has provided a cap on OPEC's capacity to impose price surges by limiting their own supply (monopoly rents), as price increases can bring to market production of unconventional sources, particularly shale, which has a shorter lead time in comparison to deep offshore.

The second lesson is that, while LC policies will be of limited gain if the capital expenditures are low per barrel produced, there are some window of opportunities to use the growing technological sophistication of the oil industry to build local R&D capacity. Some of the traditional producers, particularly Saudi Arabia and Qatar, used the years of commodity boom to boost their R&D capacity with new facilities and universities. In these efforts to promote a more knowledge-based economy, the oil industry has been instrumental. In Saudi Arabia, the state company Saudi Aramco, since 2011, devised an ambitious R&D expansion that included opening labs throughout the world (US, UK, NL, CN, SK), partnering with leading international universities (such as MIT), and sponsoring the creation of a new Saudi university, the first focused on graduate education and research (King Abdullah University of Science and Technology, opened in 2009).

Qatar opened, in 2009, a Science & Technology Park to serve as an international hub for scientific and technology innovation. The hub attracted companies like ExxonMobil, Shell, ConocoPhillips and Total, oil majors which already have operations in Qatar. Now, in addition to extracting Qatar’s natural resources, these oil companies are participating in the Qatari vision to establish a “knowledge economy,” which includes the attraction of Western universities, and the provision of funding and tax benefits for research-related activities (Siddiqi and Anadon 2017).

These efforts are definitely helping to build scientific and human resource capacity in a region that historically lacked them and preferred to spend its oil rents on other priorities. The growth of R&D in Arab countries and the role played by oil companies is worth further study. A big question is if capacity will pressure other institutional factors of the political economy of Arab countries that inhibit collaboration, free discussion and entrepreneurship. As Zahlan (2012) argues, to fully benefit from a growing scientific capacity, the Arab World will need to face domestic political challenges, which includes removing the constraints on freedom of association so scientific societies can grow and influence research priorities.

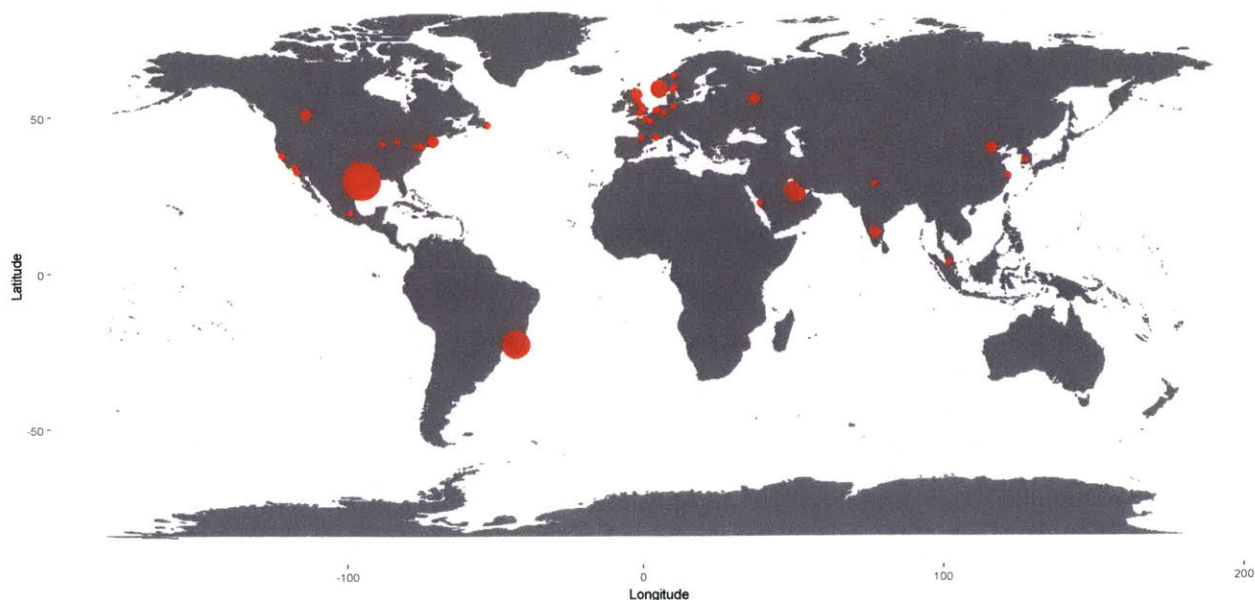


Figure 7.1: Global R&D centers of the O&G industry

The world map of natural resource extraction looks very different than the map of knowledge creation, even in the natural resource industry. But here there are also policy opportunities. Figure 7.1

shows the localization of 68 O&G global research centers, compiled with data from the major IOCs (ExxonMobil, Chevron, Total, Shell, BP), selected NOCs (Petrobras, Pemex, Petronas, Saudi Aramco, Statoil) and key oilfield service providers and equipment suppliers (GE O&G, Schlumberger, TechnipFMC). The disposition of R&D centers across the globe largely reflect the predominance of the US and Europe – the latter mostly a resource-poor area. The US concentrates the largest numbers of corporate R&D centers, 18 of them, with Houston alone hosting 7 different units. However, it is worth noting that Rio de Janeiro appears as a major outlier in the Global South as the host of 5 different corporate R&D centers – a direct result of demand and policies that earmarked R&D rents to universities and labs. The Middle East, with new initiatives by Qatar and the push by Saudi Aramco, also shows that conventional oil producers are beginning to play the R&D game, although driven more by leadership preference and national policies than business' needs, so questions remain if it will be sustainable.

To be sure, this data does not reflect a qualitative assessment of the output produced by each R&D lab or its relative resource size. Instead, it displays that while corporate R&D in O&G is globally concentrated, there are pockets of research activity outside the US and Europe, that Brazil is a major one, and that conventional producers are also making inroads. It shows that public policies can transform black gold into grey matter by successfully attracting corporate R&D and channeling resources to universities and research and technology organizations (RTOs).

4. Theoretical implications

This work departs from the resource curse literature in important ways. It starts by showing the limitations of the claims that the oil industry is necessarily an enclave-like operation that generates substantive rents to governments but no spillover to the economy in terms of jobs and opportunities in the supply chain. By doing this, this study breaks new ground against a long tradition that includes development economists like Prebisch (1950) and Hirschman (1958) and also contemporary political scientists like Dunning (2008) and Ross (2012). As I show, in high-cost oil production, the demand for capital goods and services, coupled with high levels of outsourcing of the oil industry and its modular characteristics, allow local companies to gradually become integrated in the value chain. Furthermore, suppliers and workers will pressure governments (resource-owners) to facilitate such integration by using their power to determine the regulations of access to resources (local content requirements) and invest in public goods that build local capabilities, such as training. This political pressure towards

upstream linkages and building capabilities to sustain local content policies is another significant contribution.

Extraction costs, which affects political incentives, vary according to geological endowment but geology as a variable has been overlooked in resource curse studies. In fact, I claim that the oil industry has been misrepresented by this literature. The predominant model that guides studies in this tradition sees the oil industry as a mere provider of rents to governments and not much else. The literature ignores variations that arise from different geological endowments because it assumes that oil necessarily generates high rents (Ross 2012) or because it claims that geology does not matter to the key choices rulers make about the resource sector (Luong and Weinthal 2010). These studies see the bargaining issues between oil companies and host governments as only being about who can exploit (access to resources and the role of National Oil Companies) and government take (how much rents flow directly to governments). Local content, through industrial and innovation policies in the upstream of the production chain, and their political drivers, are mostly absent in the discussions of oil politics in the resource curse literature.¹²⁹ Furthermore, LC has been a key issue in contract negotiations between oil companies, host governments, local firms and workers (Tordo et al. 2013, Warner 2011). Hence, the mainstream of the literature has missed an important component that can play a role in aiding governments in oil-rich countries to use the oil sector as a resource blessing.

Natural resources, and O&G in particular, have not been considered a “high-tech” industry or one with capacity to generate demand for local jobs and goods. This view is in direct contradiction with how the industry developed, and the role it played, in resource-rich developed economies, like the US, Canada, and Norway, but also developing nations, like Brazil and Malaysia. The problem is partly a result of the cognitive lenses used: if, when analyzing the oil industry, one uses as a mental model a huge reservoir that is easy to exploit, has low costs of production and generates high rents to governments, it is hard to think of the oil industry as anything but an enclave. This model fits well the cases of super giant fields like Ghawar, in Saudi Arabia, or Cantarell at its peak production, in Mexico. It does not, however, fit the reality of technically complex fields that require that operators procure goods and services across the country and the world, and generate much lower rents per barrel. The latter, such as shale in the US or deep offshore in Brazil and Malaysia, is the type of resource where most of the production growth of the oil industry will come from in the coming years. And, as shown in this work, the type of endowment has an effect on total economic rent per barrel and how much it is captured in

¹²⁹ With few exceptions, like Ovadia (2016a, 2016b), Tordo et al. (2013), Almeida and Martinez-Prieto (2014).

the form of taxes (government take), on the rules that define who can extract (access to resources), and whether oil companies will be pressured to procure goods and services domestically (local content). These new pressures on the rules of distribution and institutional complementarities to the productive process form the new oil politics, and to understand them it is necessary to recognize how natural resources endowment affect costs of production. Furthermore, by unpacking the industry structure in its value chain, it is possible to understand the possibilities and pressures for linkages that drive LC policies.

In a way, I reach different conclusions because I am looking at a segment of the industry that is the high-cost production, while most of the literature concentrates on OPEC countries and other low cost producers (such as Russia or Mexico). The contrast in economic activity from places with plentiful conventional oil versus others who have to constantly invest in new drilling and technology to replace reserves and maximize the output of marginal fields is colossal. Take, for instance, a Middle Eastern producer like Iraq. From the beginning of oil production up to the mid-2000s, only 2,300 wells have been drilled in Iraq. In contrast, in Texas alone more than a million wells have been drilled in the same period (Maugeri 2006, p. 222). To drill those million wells required oil workers, drilling rig machines, pipes, drilling fluids, etc. It should not be a surprise that oil in a country with a Middle East geology can be a source of easy rents, but extraction activities in high-cost basins will also be a source of industrial demand. Far from just a story about how places differ in terms of institutions, this contrast shows the relevance of understanding how different geological endowments can trigger varying levels of economic activities and political incentives.

I, thus, side with works that see a resource-blessing effect, where the natural resource industry can be an important contributor to technological development, as Wright and Czelusta (2004) show for the United States; Hatakenaka et al. (2006), Ville and Wicken (2012) and Ryggvik (2014) for Norway and the UK; and de Ferranti et al. (2002) for Sweden, Australia, and Canada. To this branch of the literature I contribute by articulating the mechanisms that link extraction costs to political incentives, by showing the role of Schumpeterian (innovation) rents to resource wealth, and by providing a careful hypothesis testing based on countries that have similar institutional and developmental levels but vary in terms of their geological endowment. This study, thus, theorizes and extends the resource blessing view beyond a handful of cases previously analyzed by the literature.

In other important areas, the theory here developed and empirical findings do not contradict works that point out desirable objectives and particular instruments to manage resource wealth – at

least the rents component of it. These include a) insulating the economy from booms and busts by adopting fiscal rules and implementing sovereign wealth funds to stabilize revenues over time; b) managing the exchange rate in ways to avoid overvaluation to preserve the competitiveness of the non-oil sector of the economy; and c) promoting transparency on the flow of revenues from the oil sector to increase public accountability as well as invest in state capacity and the rule of law. These are objectives highlighted by a number of scholars and policy practitioners, including Barma et al. (2012), Hendrix and Nolan (2014), and Sachs (2007). For instrumental and normative reasons, I find them important and desirable, but they tend to miss the role of productive policies to build industrial linkages in the supply chain. Furthermore, this set of “good” rules are unlikely to be sustained by externally-induced technocratic decisions regardless of the domestic political incentives, a point also recognized by Barma et al. (2012). At the risk of stating a truism, good macroeconomic management and rule of law are desirable – but that is true for producers of high-cost oil, low-cost oil, or no oil.

I identify two other major gaps in the resource-curse literature: first, it lacks a conceptualization of how rents can be captured or created; second, it ignores the industry structure and its capital and technological demands. If rents are critical to understand how resource wealth will affect political actors, geology has to be taken into account since endowments can vary and, consequently, affect the levels of rent availability and technical challenges. Whereas conventional oil generates high rents (because of its lower cost of production), has short lead time and can be produced with off-the-shelf technologies, unconventional resources have a higher cost of production and trigger more demand for technological solutions, capital and operational investments, and skilled personnel. Those reasons justify a closer look at the sources of rents and how geological factors may affect their availability. This work has provided a model for understanding the process of reserve creation through the lenses of Schumpeterian rents and also provided an analysis of the O&G value chain and the many points of entry that can be subject to industrial policies.

Another issue that deserves further attention in this field is that the growth of output from unconventional sources, and consequently the increase in the spread of costs between oil producers, brings serious measurement challenges to the resource curse literature, particularly cross-country regression studies. The lack of an unequivocal measure in this literature is a well-known problem: B. Smith (2012) identifies eleven different choices of measuring oil wealth in published papers, including a simple dummy for membership in OPEC, the share of oil exports in the country’s total exports, and oil rents per capita, and they all have some conceptual and/or endogeneity problems. However, if the main

mechanism that translates resource abundance to political consequences is the availability of oil rents that flow to governments, as argues the bulk of the literature reviewed in Chapter 2, a measure of oil rents per capita seems a good proxy because it more closely reflects the hypothesized mechanism. Ross (2012) advances a measure of oil rents per capita based on oil production times yearly price and claims the superiority of this indicator given its easiness to calculate for several countries and conceptual advantages over measures that reflect export dependency and the size of the non-oil economy (such as share of oil exports). I concur on the conceptual superiority of this measurement over previous ones, but its operationalization becomes increasingly problematic because it hinges on the assumptions that costs of production are negligible and that they are the same across countries. Because production costs vary according to geological conditions and type of resource, Ross' (2012) measure will tend to overestimate the amount of available rents in countries that produce oil in frontier areas (or even that produce heavy oil, which is sold at a discount). A correct measure of oil rents requires the subtraction of production costs, a type of data that, unfortunately, is not readily available for most countries but the collection of which will be increasingly important to truly assess the impact of oil wealth on politics. The challenge here is to obtain more sources (or proxies) of production costs, although costs in the oil industry are "exceedingly hard to find and document" (Aguilera and Radetzki 2015, p. 37), which may limit cross-country comparisons.

Finally, are unconventional oil producers immune to the resource curse? Is local content both a good tool for politics – by building new coalitions based on supply chain participation – and for economic development? On the one hand, local content creates incentives for public goods investments on the part of the government (such as education and R&D) and technology transfer from oil companies to local suppliers, and through these channels contribute to economic growth and economic diversification, helping to escape the curse. Furthermore, by adopting policies that encourage the employment of national workers instead of expatriates, it is likely to contribute to increased political engagement by workers and demand for public goods, and, through this channel, more accountable governments. On the other hand, much of the potential for industrial linkages and local capability building depend on the design of industrial policies, which can be quite challenging in the oil sector. Therefore, geology alone cannot make a resource blessing. It can, however, minimize a curse: higher production costs will mean that there will be less rents to seek, reducing opportunities for corruption and mismanagement in comparison to a counterfactual of conventional oil. Therefore, to use a gold rush analogy, at best unconventional oil and local economic integration can be like selling shovels in a gold rush. At worst, because the "gold" is hard and costly to find, it will be a less disastrous and chaotic rush.

In the course of this study I have interacted with many actors of the long O&G value chain during interviews, technical meetings, specialized courses and recruitment panels. I will finish by recounting a meeting that took place in the Spring of 2017, when executives from an IOC came to MIT to highlight work opportunities in the O&G industry, with a particular focus on recruiting African students. After talking about their presence in the African continent and the types of jobs available, one of the executives (a geologist in his 50s, born in Angola) mentioned to the group of students the effect of LC legislations in their recruitment efforts and work force mobility. New LC requirements imposed caps on the amount of expatriate workers that their company could use, particularly in Nigeria, which led to an increase in their efforts to train locals and recruit African students studying in international universities. The company also had to increase their purchase of (partially) locally manufactured platforms, such as from shipyards in Angola. Both Angola and Nigeria have been experiencing, since the mid-2000s, strong growth in deep offshore oil exploration and production and pushed to localize more of the activities within their countries. This example shows how new political demands are changing the types of engagement of oil operators with host countries. Some years ago, politicians in many countries were satisfied with staffing oil activities with expatriate employees working on foreign-made equipment, as long as the share of revenues that flowed to governments was secured. However, nowadays oil politics have changed and the theoretical literature about them has to change as well to reflect the new distributive struggles and developmental possibilities.

Appendix:

List of interviews

Name, position at the time of interview, and date. The list is divided primarily by the country expertise of the interviewee. Several interviews are not listed and a few interviewees have their name omitted to protect anonymity.

Mexico

Acra, Juan. Head of the Energy Committee at COPARMEX. 08/14/2015.

Porres, Alma América. Commissioner at CNH and formerly at IMP. 06/30/2015.

Beauregard, Mario. Chief Financial Officer of Pemex. 08/11/2015.

Camarillo, Rubens. Federal deputy (PAN). 08/05/2015.

Cota, Marco. General Director of Exploration and Production (E&P) at the Ministry of Energy and former CNH. 07/29/2015.

Diaz, Cybele. Former local content manager at Pemex. 06/25/2015.

Dominguez Vergara, Nicolas. Professor at The Metropolitan Autonomous University (UAM) and former IMP researcher. 07/14/2015.

Elizondo, Carlos. Professor at CIDER and independent board member of Pemex since 2014. 07/02/2015.

Garcia Alcocer, Guillermo. Head of Public Policy on Exploration and Extraction of Hydrocarbons at the Ministry of Energy (SENER), 08/25/2015.

Garcia, Alfredo. Vice President of BP Mexico. 08/18/2015.

Garza Garza, Rogelio. Undersecretary of Industry and Trade at the Ministry of Economy. 08/07/2015.

Lajous, Adrian. Former CEO of Pemex (1994-1999). 08/17/2015.

Marquez Soliz, Hector. Head of Local Content Development, Ministry of Economy. 06/24/2015.

Melgar, Lourdes. Former deputy-minister for Hydrocarbons (Sener), Mexico. Cambridge, MA, 11/23/2016.

Messmacher Linartas, Miguel. Undersecretary for Revenues in Mexico's Ministry of Finance and Public Credit. 08/10/2015.

Murietta, Carlos. Former Corporate Director of Operations at Pemex (2009-2015). 07/20/2015.

Ortiz Gomez, Carlos Roberto. Director-General for Research and Talent Development at the Ministry of Energy. 08/27/2015.

Rangel Germán, Edgar. Commissioner at CNH and former Pemex employee. 06/23/2015.

Reyes Heróles Gonzales-Garza, Jesus. Former CEO of Pemex (2006-2009) and Ministry of Energy (1995-1997). 08/04/2015.

Rios Patrón, Ernesto. General director of IMP and former subdirector at Pemex. 06/29/2015.

Rivas, Sergio. Mexican representative of the Norwegian Oil and Gas Partners (INTSOK), 07/31/2015.

Serra Puche, Jaime. Consultant and former Minister of Economy (1988-1994). 08/11/2015.

Silva López, Pedro. Chief Technology Officer, PEMEX. 08/06/2015.

Torres, Karla. Manager at Shell's Mexico Sourcing Office. 08/19/2015.

Zepeda, Juan Carlos. President Commissioner at the National Hydrocarbon Commission (CNH). 06/30/2015.

Brazil

Almeida, Marcos Antonio. Secretary of Oil, Natural Gas and Renewable Fuels, Ministry of Mines and Energy. Brasília (DF), 08/07/2014.

Arbix, Glauco. Head of the Funding Authority for Studies and Projects (Finep, Federal Government). Cambridge, MA, 09/11/2014.

Bastos, Braulio Luis. Director of Engineering at Sete Brasil and former Petrobras employee. Rio de Janeiro, 04/07/2015.

Canêdo, Maurício. Researcher at Getulio Vargas Foundation (FGV) and consultant for Transpetro/Petrobras. Rio de Janeiro, 08/14/2012.

Carvalho, Florival. Director at the National Agency of Petroleum (ANP). Rio de Janeiro, 08/14/2012.

Cerqueira, Renato. Senior Manager of Natural Resources Solutions at IBM Brazil. Rio de Janeiro, 04/09/2015.

Chamusca, Eduardo. Business Director at SBM. Rio de Janeiro, 02/12/2016.

Costa, Amilton. Public Policy Analyst for the Oil and Gas Sector, National Confederation of Industries (CNI), 08/13/2012.

Costa, Ricardo. Head of the O&G Supply Chain Department at BNDES. Rio de Janeiro, 02/12/2016.

Dan Júnior, Edival. Local Content Manager at Petrobras, 04/08/2015.

Estefen, Segen. Professor at Coppe/UFRJ and member of the board of Petrobras, Rio de Janeiro, 02/16/2016.

Ferreira, José Mauro. Business Director at FMC Technologies Brazil. Rio de Janeiro, 02/16/2016.

Fonseca, Ivan. General Manager at Brasa Shipyard. Rio de Janeiro, 05/17/2016.

Guimarães, Antônio. Director of the Brazilian Institute of Petroleum (IBP). Rio de Janeiro, 08/17/2012.

Leal, Sérgio. Executive Secretary of The National Association of Shipbuilding and Offshore Construction and Repair Industry (SINAVAL). Rio de Janeiro, 08/15/2012.

Machado Neto, Alberto. Executive Director of O&G at The Brazilian Machinery Builders' Association (ABIMAQ). Rio de Janeiro (through skype), 01/27/2016.

De Negri, João. Director of Innovation at the Funding Authority for Studies and Projects (Finep, Federal Government). Rio de Janeiro 08/15/2012 and Cambridge, MA, 10/15/2015.

Passos, Vinícius. Local Content Manager at Queiroz Galvão E&P (QGEP). Rio de Janeiro, 02/11/2016.

Peixoto, Ricardo. CEO of Petrogal/Galp Brasil. Recife, 08/21/2012.

Pompeu, André Mendes. Manager of the O&G Supply Chain Department at BNDES. Rio de Janeiro, 02/12/2016.

Reis, Marcos. Researcher at the Brazilian Institute of Robotics at Senai/Cimatec, Salvador (BA), 10/21/2015.

Rennó, Joel. Consultant and former CEO of Petrobras (1992-1999). Rio de Janeiro, 08/16/2012.

Rodrigues, Marco Túlio. Local Content Coordinator at ANP. Rio de Janeiro, 04/09/2015.

Dos Santos, Eduardo. Manager of Relationship with the Scientific and Technology Community at Cenpes/Petrobras. Rio de Janeiro, 03/20/2015.

Dos Santos, José Botelho. director of the O&G Exploration and Production Policy Department, Ministry of Mines and Energy. Brasília (DF), 08/07/2014.

Vilaça, Farley. Business Development Manager at GE O&G/Marine (Brazil). Rio de Janeiro, 04/10/2015.

Malaysia

Abdullah, Azhar. Vice-president of Shared Services Asia at Schlumberger. Kuala Lumpur, 03/24/2016.

Bin Talib, Faridon. Vice President at Technip Geoproduction Malaysia. Kuala Lumpur, 03/29/2016.

Darman, Nasir B. Chief Technology Officer of Petronas. Kuala Lumpur, 01/13/2017.

Hashim, Datuk Ismail. Founding member of Petronas and former senior vice-president. Kuala Lumpur, 04/12/2016.

Madros, Shahreen Zainooreen. Executive-director of the Malaysia Petroleum Resources Corporation (MPRC). Kuala Lumpur, 03/15/2016.

Petronas executive 1, Procurement, Project Delivery & Technology. Kuala Lumpur, 04/07/2016.

Petronas executive 2, Procurement, Project Delivery & Technology. Kuala Lumpur, 04/07/2016.

Petronas executive 3, Human Capital and Capability Development. Kuala Lumpur, 04/15/2016.

Petronas executive 4, Human Capital and Capability Development. Kuala Lumpur, 04/15/2016.

Robinson, Kevin. Vice-president for Asia at SapuraKencana E&P. Kuala Lumpur, 03/24/2016.

Satria, Kasuma. Vice President of Business Development at Technip Consultant Sdn Bhd. Kuala Lumpur, 03/29/2016.

Vicente, João. Consultant for the oil industry and former Schlumberger employee in Malaysia. Rio de Janeiro (BR), 05/11/2016.

Yahaya, Ahmad Fairuz. Business development manager at SBM Offshore. Kuala Lumpur, 03/16/2016.

References

- Abidin, Mahani Zainal. 2001. "Competitive Industrialization with Natural Resource Abundance: Malaysia." In *Resource Abundance and Economic Development*, edited by R. M. Auty. New York: Oxford University Press.
- Acemoglu, Daron, and James Robinson. 2012. *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. New York: Random House.
- Adelman, M.A. 1993. *The Economics of Petroleum Supply*. Cambridge, MA: MIT Press.
- Adelman, M.A. 1995. *The Genie Out of the Bottle: World Oil Since 1970*. Cambridge, MA: MIT Press.
- Aguilera, Roberto F. 2014. "Production costs of global conventional and unconventional petroleum." *Energy Policy*, 64, 134–140. <http://doi.org/10.1016/j.enpol.2013.07.118>
- Aguilera, Roberto F., and Marian Radetzki. 2015. *The Price of Oil*. Cambridge: Cambridge University Press.
- Almeida, Edmar and Diana Martinez-Prieto. 2014. "The impact and effectiveness of local content policy on oil exploration and production in Brazil." *Oxford Energy Forum*, Nov. 2014, Issue 98.
- Almeida, Edmar, Luciano Losekann, William Adrian Clavijo Vitto, Luciana Nunes, Felipe Botelho, Felipe Costa, Luiza Waeger. 2016. "Custos e Benefícios da Atual Política de Conteúdo Local" *Ciclo de Debates sobre Petróleo e Economia - Texto para Discussão*. Available at: http://www.ibp.org.br/personalizado/uploads/2016/11/2016_TD_Custos-e-Benef%C3%ADcios-da-Pol%C3%ADtica-Conte%C3%BAdo_Local-final.pdf
- Almeida, Mansueto, Renato Lima-de-Oliveira, Ben Ross Schneider. 2014. "Política industrial e empresas estatais no Brasil: BNDES e Petrobras." In *Capacidades Estatais e Democracia: Arranjos Institucionais de Políticas Públicas*. Ed. Alexandre de Ávila Gomide e Roberto Rocha C. Pires. Brasília: IPEA
- Am, Knut, and Sigurd Heiberg. 2014. "Public-Private Partnership for Improved Hydrocarbon Recovery - Lessons from Norway's Major Development Programs." *Energy Strategy Reviews* 3 (C). Elsevier Ltd: 30–48. doi:10.1016/j.esr.2014.06.003.
- Amsden, Alice. 2001. *The Rise of The Rest: Challenges to the West from Late-Industrializing Economies*. New York: Oxford University Press.
- Andersen, J. J., & Ross, M. L. 2014. "The Big Oil Change: A Closer Look at the Haber–Menaldo Analysis." *Comparative Political Studies*, 47(7), 993–1021. doi:10.1177/0010414013488557
- Anfavea. 2015. *Brazilian Automotive Industry Yearbook*. São Paulo: Brazilian Automotive Industry Association.
- ANP. 2013. "Production Sharing Contract for Exploration and Production of Oil and Natural Gas." Available at: http://www.brazil-rounds.gov.br/arquivos/Edital_p1/Minuta_Edital/minuta_contrato_autorizada_09072013_ingles.pdf
- ANP. 2016. "Boletim ANP - Petróleo e P&D: Boletim Sobre a Aplicação dos Recursos Provenientes da Cláusula de P, D&I e do PRH-ANP." *Edição 33*, Maio de 2016. Rio de Janeiro: ANP.
- Aris, Azam. 2008. *The Quintessential Man: the Story of Tan Sri Azizan Zainul Abidin*. Selangor (Malaysia): Crestime Holdings Sdn Bhd.
- Ascher, William. 1999. *Why Governments Waste Natural Resources: Policy Failures in Developing Countries*. Baltimore: The Johns Hopkins University Press.
- Auty, R. M. 1993. *Sustaining development in the mineral economies: The resource curse thesis*. London: Routledge.
- Bain & Company and Tozzini Freire. 2009. *Relatório III – Desenvolvimento da Cadeia Produtiva de Petróleo e Gás e Investimentos em E&P*. São Paulo: BNDES.

- Balakrishnan, Balamugilan. 2002. *Developing technological capabilities on the upstream petroleum sector: a case study of Petronas*. Masters thesis, University of Malaya.
- Baraf, Josef, Carlos Alvares da Silva Campos Neto, Jean Marlo Pepino de Paula. 2014. "Visão Econômica da Implantação da Indústria Naval no Brasil: Aprendendo com os Erros do Passado." In *Ressurgimento da indústria naval no Brasil: 2000-2013*. Edited by Carlos Alvares da Silva Campos Neto and Fabiano Mezadre Pompermeier. Brasília: IPEA.
- Barbosa Cano, Fábio. 1992. "Technical and Economic Problems of the Newly Nationalized Industry." in *The Mexican Petroleum Industry in the Twentieth Century*. Edited by Jonathan C. Brown and Alan Knight. Austin, TX: University of Texas Press.
- Barbosa Cano, Fábio. 2012. *Retos en la exploración y producción de petróleo crudo en el sexenio 2012-2018*. Mexico (DF): UNAM.
- Barma, Naazneen H., Kai Kaiser, Tuan Minh Le, and Lorena Viñuela. 2012. *Rents to Riches? The Political Economy of Natural Resource-Led Development*. Washington: The World Bank.
- Bartlett Díaz, Manuel, and Víctor Rodríguez Padilla. 2008. *El Petróleo y Pemex: Despojo a la Nación*. México (DF): Manuel Bartlett Díaz.
- Bennett, Andrew, and Jeffrey T. Checkel. 2015. "Process tracing: from philosophical roots to best practices." In *Process tracing: from metaphor to analytic tool*. Edited by Andrew Bennett and Jeffrey T. Checkel. New York: Cambridge University Press.
- Berkowitz, Daniel, Katharina Pistor, and Jean-Francois Richard. 2003. "The transplant effect." *The American Journal of Comparative Law*: 163-203.
- Bermúdez, Antonio J. 1976. *La Política Petrolera Mexicana*. México (DF): Editorial Joaquín Mortiz S.A.
- Bhattacharyya, Subhes C. 2011. *Energy Economics: Concepts, Issues, Markets and Governance*. London: Springer.
- BMI Research. 2016. *Malaysia Oil & Gas Report – Q1 2017*. London: BMI Research.
- BNDES. 2014. *Perspectivas do Investimento 2015-2018 e Panoramas Setoriais*. Rio de Janeiro: BNDES/APE/DEPEQ.
- Boas, T. C., Hidalgo, F. D., & Richardson, N. P. 2014. "The Spoils of Victory: Campaign Donations and Government Contracts in Brazil." *The Journal of Politics*, 76(02), 415–429. <http://doi.org/10.1017/S002238161300145X>
- Boo, Cheng Hau. 1998. *Quotas versus affirmative action: A Malaysian Perspective*. Kuala Lumpur: Oriengroup Sdn. Bhd.
- Bowie, Paddy. 2001. *A Vision Realised: the Transformation of National Oil Corporation*. Kuala Lumpur (Malaysia): Orillia Corporation Sdn Bhd.
- BP. 2015a. *Energy Outlook 2035*. Available at: <http://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2015/bp-energy-outlook-2035-booklet.pdf>
- BP. 2015b. *Statistical Review of World Energy*. Available at: <http://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf>
- BP. 2016. *Statistical Review of World Energy 2016*. Available at: <http://www.bp.com/content/dam/bp/excel/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-workbook.xlsx>
- Bret-Rouzaut, Nadine, Favennec, Jean-Pierre. 2011. *Oil and Gas Exploration and Production - Reserves, Costs, Contracts (3rd Edition Revised and Updated)*. Editions Technip. Online version available at: <http://app.knovel.com/hotlink/toc/id:kpOGEPGCC2/oil-gas-exploration-production/oil-gas-exploration-production>
- Bridgman, B., Gomes, V., & Teixeira, A. 2011. "Threatening to increase productivity: Evidence from Brazil's oil industry." *World Development*, 39(8), 1372–1385.

- Brooks, Sarah, and Marcus J. Kurtz. 2016. "Natural Resources and Economic Development in Brazil." In *New Order and Progress: Development and Democracy in Brazil*. Edited by Ben Ross Schneider. New York: Oxford University Press.
- Bueno de Mesquita, Bruce, Alastair Smith, Randolph M. Siverson and James D. Morrow. 2003. *The Logic of Political Survival*. Cambridge: MIT Press.
- Campos Neto, Carlos Alvares da Silva e Fabiano Mezadre Pompermeyer (eds). 2014. *Ressurgimento da indústria naval no Brasil: 2000-2013*. Brasília: IPEA.
- Campos Neto, Carlos Alvares da Silva, 2014. "Investimentos na indústria naval brasileira 2000-2013" In *Ressurgimento da indústria naval no Brasil: 2000-2013*. Edited by Carlos Alvares da Silva Campos Neto and Fabiano Mezadre Pompermeyer. Brasília: IPEA.
- Cardoso, Fernando Henrique. 2013. "Prefácio." In *Petróleo: Reforma e Contrarreforma do Setor Petrolífero Brasileiro*. Edited by Fábio Giambiagi and Luiz Paulo Vellozo Lucas. Rio de Janeiro: Elsevier.
- Casar, José I., and Jaime Ros. 1989. "Una visión de conjunto." In *México: Informe sobre la crisis (1982-1986)*. Edited by Carlos Tello. México (DF): Universidad Nacional Autónoma de México.
- Casar, M. A. 2013. "Quince años de gobiernos sin mayoría en el Congreso mexicano." *Política Y Gobierno*, 219–263.
- Castañeda, Jorge G. 1999. *La herencia: Arqueología de la sucesión presidencial en México*. México (DF): Extra Alfaguara.
- Cavalheiro, G.M. do C., Joia, L.A., & Gonzalves, A.C., 2014. "Strategic patenting in the upstream oil and gas industry: Assessing the impact of the pre-salt discovery on patent applications in Brazil." *World Patent Information*, 39, 58–68. <http://doi.org/10.1016/j.wpi.2014.04.003>
- Cheon, A., Urpelainen, J., & Lackner, M. 2013. "Why do governments subsidize gasoline consumption? An empirical analysis of global gasoline prices, 2002-2009." *Energy Policy*, 56, 382–390. <http://doi.org/10.1016/j.enpol.2012.12.075>
- Clarkson Research Service. 2012. *World Shipyard Monitor*, June 2012. London: Clarkson Research Service.
- Clarkson Research Services (CRS). *World Shipyard Monitor* (various years).
- Clô, Alberto. 2000. *Oil Economics and Policy*. New York: Springer Science+Business Media.
- CNH. 2010a. *Documento Técnico 1 (DT-1): Factores de recuperación de aceite y gas en México*. México (DF): CNH.
- CNH. 2010b. *Proyecto Aceite Terciario del Golfo - Primera Revisión y recomendaciones*. Mexico (DF): CNH and Sener.
- CNH. 2011. *Segunda resolución relativa a la aprobación de los reportes de evaluación y cuantificación de reservas de hidrocarburos*. Available at http://www.cnh.gob.mx/_docs/resoluciones/nota_adjunta_a_resolucionv2.pdf
- Coelho, José Ricardo Roriz. 2017. "A política de conteúdo local na indústria de petróleo e gás natural." *Fiesp/Departamento de Competitividade e Tecnologia*. São Paulo: Fiesp.
- Collier, P. and Anke Hoeffler. 2005. "Resource Rents, Governance, and Conflict." *Journal of Conflict Resolution*, 49(4), 625–633. doi:10.1177/0022002705277551
- Collier, P. 2010. "The Political Economy of Natural Resources." *Social Research*, 77(4), 1105 – 1132.
- Collier, Paul, and Anthony J. Venables. 2011. "Key Decisions for Resource Management – Principles and Practice." In *Plundered Nations? Successes and Failures in Natural Resource Extraction*. Edited by Paul Collier and Anthony J. Venables. New York: Palgrave MacMillan.
- Columbia Center on Sustainable Investment (CCSI). 2016. *Local Content - Malaysia - Petroleum*. Available from: <http://ccsi.columbia.edu/files/2014/03/Local-Content-Malaysia-Petroleum-CCSI-Sept-2016.pdf>

- Coronado, Laura. 2014. *El Capital Humano y la Innovación en la Industria Energética*. Mexico (D.F.): Editorial Porrúa.
- Coutinho, Luciano, João Carlos Ferraz, André Nassif, and Rafael Oliva. 2012. "Industrial policy and economic transformation." In *The Oxford Handbook of Latin American Political Economy*. Edited by Javier Santiso and Jeff Dayton-Johnson. New York: Oxford University Press.
- Cuaresma, J., Oberhofer, H., & Raschky, P. a. 2010. "Oil and the duration of dictatorships." *Public Choice*, 148(3–4), 505–530.
- Dantas, E., & Bell, M. 2011. "The Co-Evolution of Firm-Centered Knowledge Networks and Capabilities in Late Industrializing Countries: The Case of Petrobras in the Offshore Oil Innovation System in Brazil." *World Development*, 39(9), 1570–1591.
- de Ferranti, David, Guillermo Perry, Daniel Lederman, and William Maloney. 2002. *From Natural Resources to the Knowledge Economy*. Washington (DC): World Bank.
- Dekker, M., McEvilly, M., Beattie, M., Laws, B., Yanosek, K., Goodwin, D., & Khurana, S. 2016. *Energizing Worldwide Oil and Gas Deepwater Developments*. Offshore Technology Conference. doi:10.4043/27317-MS
- Departamento de Coordenação e Governança das Empresas Estatais (DEST). 2016. *Perfil das Empresas Estatais Federais - 2015 (Ano-Base 2014)*. Brasília: Ministério do Planejamento, Desenvolvimento e Gestão.
- Devereux, Steve. 2012. *Drilling Technology (2nd edition)*. Tulsa (OK): PennWell Corporation.
- Dias, José Luciano de Mattos, and Maria Ana Quagliano. 1993. *A questão do petróleo no Brasil: uma história da Petrobrás*. Rio de Janeiro: FGV / Petrobras.
- Díaz-Cayeros, Alberto. 2013. "Entrenched insiders: Limited Access Order in Mexico." In *The Shadow of Violence: Politics, Economics, and the Problems of Development*. Edited by Douglass C. North, John J. Wallis, Steven B. Webb, Barry R. Weingast. New York: Cambridge University Press.
- Domínguez Vergara, Nicolás and Reynaldo Vela Coreño. 2015. *Y los Veneros de Petróleo el Diablo*. México (DF): GSM Comunicaciones y Negocios S.A. de C.V..
- Dominguez Vergara, Nicolás and Yadira Zavala Osorio. 2008. "Investigación y desarrollo tecnológico en la industria petrolera mexicana." In *Pemex: Presente y Futuro*, Francisco Colmenares César, Fabio Barbosa Cano, Nicolás Domínguez Vergara (eds). México, D.F.: Universidad Autónoma Metropolitana.
- Domínguez Vergara, Nicolás. 2008. "¿Por qué no desarrollamos tecnología para aguas profundas?" *Revista Este País*. No. 206. Pages 20-27. Mayo de 2008.
- Donnelly, J. 2014. "Comments: Innovation Follows Price". *Journal of Petroleum Technology*, 66(11), 18-18.
- Dowding, K., John, P., Mergoupis, T., & Van Vugt, M. 2000. "Exit, Voice and Loyalty: Analytic and Empirical Developments." *European Journal of Political Research*, 37(4), 469–495.
- Doyle, D. 2014. "The Political Economy of Policy Volatility in Latin America." *Latin American Politics and Society*, 56(4), 1–21. doi:10.1111/j.1548-2456.2014.00246.x
- Dunning, Thad. 2008. *Crude Democracy: Natural Resource Wealth and Political Regimes*. New York: Cambridge University Press.
- Dunning, T. 2010. "Endogenous Oil Rents." *Comparative Political Studies* 43 (3): 379–410. doi:10.1177/0010414009352649.
- Economic Planning Unit. 1971. *Second Malaysia Plan, 1971-1975*. Kuala Lumpur: Government Printers.
- Economist. 2012. *The unsung masters of the oil industry* (Jul 21st 2012). Available at <http://www.economist.com/node/21559358>
- Edquist, Charles, and Franco Malerba, J. Stan Metcalfe, Fabio Montobbio and W. Edward Steinmueller. 2004. "Sectoral systems: implications for European innovation policy." In *Sectoral Systems of*

- Innovation: Concepts, Issues and Analyses of Six Major Sectors in Europe*. Edited by Franco Malerba. Cambridge: Cambridge University Press.
- Elizondo, Carlos. 2012. *Con Dinero y Sin Dinero: Nuestro ineficaz precario e injusto equilibrio fiscal*. [Kindle version]. Retrieved from Amazon.com
- Energy Information Agency (EIA). 2013. *Technically Recoverable Shale Oil and Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States*. June 13, 2013.
- Energy Information Agency (EIA). 2015. *U.S. Crude Oil and Natural Gas Proved Reserves, 2014*. Release date: November 23, 2015. Available at: <http://www.eia.gov/naturalgas/crudeoilreserves/>
- Espinasa, Ramón. 2016. "Brand New Model, Same Old Price." *Inter-American Development Bank Technical Note 937*. Washington, DC: IDB.
- Evans, Peter. 1995. *Embedded Autonomy: States and Industrial Transformation*. Princeton: Princeton University Press.
- EY. 2014. *US oil and gas reserves study*. Available at: [http://www.ey.com/Publication/vwLUAssets/EY-US-Oil-and-Gas-reserves-study-2014/\\$FILE/EY-US-Oil-and-Gas-reserves-study-2014.pdf](http://www.ey.com/Publication/vwLUAssets/EY-US-Oil-and-Gas-reserves-study-2014/$FILE/EY-US-Oil-and-Gas-reserves-study-2014.pdf)
- Farole, T., & Winkler, D. (Eds.). 2014. *Making Foreign Direct Investment Work for Sub-Saharan Africa*. Washington (DC): World Bank.
- Fattouh, B., & Mahadeva, L. 2013. "OPEC: What Difference has it Made?" *Annu. Rev. Resource Economics*, 427–446. doi:10.1146/annurev-resource-091912-151901
- Feige, David. 2015. "Fundamentals of Innovation Policy for Growth and Development" in *Innovation Policy: A Practical Introduction*, eds. S. Nicholas Vonortas, C. Phoebe Rouge, and Anwa Aridi. New York: Springer.
- Fernández, Eloi F. 2013. "Indústria nacional de bens e serviços nos arranjos produtivos do setor de óleo e gás natural no Brasil." In *Petróleo: Reforma e Contrarreforma do Setor Petrolífero Brasileiro*. Edited by Fábio Giambiagi and Luiz Paulo Vellozo Lucas. Rio de Janeiro: Elsevier.
- Fraser, Donald R., Hao Zhang, and Chek Derashid. 2006. "Capital structure and political patronage: The case of Malaysia." *Journal of Banking & Finance* 30.4: 1291-1308.
- Freeman, C. 1987. *Technology policy and economic performance: Lessons from Japan*. London: Pinter.
- Freire, Eloi. 2013. "Petrobras: das origens até os anos 1990" in Fábio Giambiagi and Luiz Paulo Vellozo Lucas ed., *Petróleo: Reforma e Contrarreforma do Setor Petrolífero Brasileiro*. Rio de Janeiro: Elsevier.
- Fuzetti, Fábio. 2013. Queixa contra a Petrobras protocolada na CVM em 08/19/2013.
- Gale, Bruce. 1981a. "Malaysia's National Oil Corporation." *Asian Survey*, Vol. 21, No. 11 (Nov., 1981), pp. 1129-1144.
- Gale, Bruce. 1981b. *Politics and Public Enterprise in Malaysia*. Kuala Lumpur: Eastern Universities Press Sdn. Bhd.
- Gancia, Gino, and Fabrizio Zilibotti. 2005. "Horizontal Innovation in the Theory of Growth and Development." In *The Handbook of Economic Growth*. Edited by Phillip Aghion and Steven Durlauf. New York (NY): Elsevier.
- García Páez, Benjamín. 1989. *La Política de Hidrocarburos en el Proceso de Reordenación Económica*. México D.F.: UNAM.
- García, R., Lessard, D., & Singh, A. 2014. "Strategic partnering in oil and gas: A capabilities perspective." *Energy Strategy Reviews*, 3(C), 21–29.
- García-Colín Scherer, Leopoldo. 2011. *El Petróleo de México: 1910-2010*. México (D.F.): El Colegio Nacional.
- Gaspar, Malu. 2015. "O segundo escândalo da Petrobras," *Veja*, 04/01/2015, Ed. 2419.
- Geddes, Barbara. 1994. *Politician's Dilemma: Building State Capacity in Latin America*. Berkeley: University of California Press.

- Gelb, A. & Associates. 1988. *Oil Windfalls: Blessing or curse?* New York: Oxford University Press for the World Bank.
- George, Alexander, and Andrew Bennet. 2005. *Case Studies and Theory Development in the Social Sciences*. Cambridge (MA): MIT Press.
- Ghouse, Mohamed Yusoff. 1997. *Internationalization of resource-based firms from developing countries: case of Petronas, the national petroleum corporation of Malaysia*. Thesis (M.B.A.) -- Massachusetts Institute of Technology, Sloan School of Management, 1997.
- Gillis, M., Perkins, D. H., Roemer, M., & Snodgrass, D. R. 1992. *Economics of development (No. Ed. 3)*. New York: W.W. Norton & Company, Inc..
- Gochberg, William, and Victor Menaldo. 2016. "The Resource Curse Puzzle Across Four Waves of Work." In *The Palgrave Handbook of the International Political Economy of Energy*. Edited by Thijs Van de Graaf, Benjamin K. Sovacool, Arunabha Ghosh, Florian Kern, Michael T. Klare, Mavis Puthuchearu and Norani Othman. London: Palgrave Macmillan.
- Gomez, Edmund Terence. 2002. "Introduction: political business in East Asia" In *Political Business in East Asia*, edited by Edmund Terence Gomez. New York: Routledge.
- Gomez, Edmund Terence and Jomo K.S. 1997. *Malaysia's Political Economy: Politics, Patronage and Profits*. New York: Cambridge University Press.
- Government Accountability Office (GAO). 2007. *Oil and Gas Royalties: A Comparison of the Share of Revenue Received from Oil and Gas Production by the Federal Government and Other Resource Owners*. Available at: <http://www.gao.gov/assets/100/94953.pdf>
- Greene, Kenneth. 2007. *Why Dominant Parties Lose: Mexico's Democratization in Comparative Perspective*. New York: Cambridge University Press.
- Greif, Avner. 1993. "Contract enforceability and economic institutions in early trade: The Maghribi traders' coalition." *The American Economic Review*, Jun 1: 525-548.
- Grossman, G. 1981. "The theory of domestic content protection and content preference." *Q. J. Econ.* 96 (4), 583-603.
- Grunstein, Miriam. 2010. *De la caverna al mercado: una vuelta al mundo de las negociaciones petroleras*. México, D.F.: Cidac.
- Guimarães, Eduardo Augusto. 2012. "Uma avaliação da política de conteúdo local na cadeia do petróleo e gás." In *O Futuro da Indústria No Brasil*. Edited by Edmar Bacha and Monica de Bolle Baumgarten. Rio de Janeiro: Civilização Brasileira.
- Gustafsson, Fredrik. 2007. "Malaysian Industrial Policy, 1986-2002." In *Malaysian Industrial Policy*, edited by Jomo K.S. Singapore: National University of Singapore.
- Haber, S., & Menaldo, V. 2011. "Do Natural Resources Fuel Authoritarianism? A Reappraisal of the Resource Curse." *American Political Science Review*, 105(01), 1-26. doi:10.1017/S0003055410000584
- Haber, Stephen; Herbert S. Klein, Noel Maurer, Kevin J. Middlebrook. 2008. *Mexico Since 1980*. New York: Cambridge University Press.
- Hall, Peter A., and David Soskice. 2001. "An introduction to varieties of capitalism." In *Varieties of Capitalism: The institutional foundations of comparative advantage*, edited by Peter Hall and David Soskice. New York: Oxford University Press.
- Hamilton, James D. 2008. "Understanding crude oil prices." No. w14492. National Bureau of Economic Research.
- Harberger, Arnold C. 1971. "Three basic postulates for applied welfare economics: An interpretive essay." *Journal of Economic Literature* 9.3 (1971): 785-797.
- Hashim, Ismail. 2004. *The Young Turks of Petronas*. Kuala Lumpur (Malaysia): Art Printing Works Sdn Bhd.

- Hatakenaka, Sachi, Petter Westnes, Martin Gjelsvik, and Richard K. Lester. 2006. "From 'Black Gold' to 'Human Gold': A Comparative Case Study of the Transition from a Resource-Based to a Knowledge Economy in Stavanger and Aberdeen." *MIT IPC, LIS Working Paper 06-002*, July, 2006. Cambridge, MA: MIT IPC.
- Hendrix, Cullen S., and Marcus Holand. 2014. *Confronting the Curse: the Economics and Geopolitics of Natural Resource Governance*. Washington, DC: Peterson Institute for International Economics.
- Hertzmark, Donald. 2007. "Pertamina: Indonesia's State-Owned Oil Company." Baker Institute, Rice University.
http://www.bakerinstitute.org/media/files/page/9d12f310/noc_pertamina_hertzmark.pdf
- Hines Jr., James R. 1999. "Three sides of Harberger triangles." *The Journal of Economic Perspectives*, 13(2), 167–188.
- Hirschman, Albert O. 1958. *The Strategy of Economic Development*. New Haven: Yale University Press.
- Hirschman, Albert O. 1970. *Exit, voice, and loyalty: Responses to decline in firms, organizations, and states*. Cambridge (MA): Harvard University Press.
- Hirschman, Albert O. 1978. "Exit, Voice, and the State." *World Politics*, 31, pp 90-107.
- Horiwitz, Donald L. 1989. "Incentives and behaviour in the ethnic politics of Sri Lanka and Malaysia." *Third World Quarterly* 11.4: 18-35.
- Hughes, Llwyn. 2014. *Globalizing oil: Firms and Oil Market Governance in France, Japan, and the United States*. New York: Cambridge University Press.
- Hui, Wee Chong. 2012. "Malaysia" in *Oil & Gas in Federal Systems*, ed. George Anderson. Ontario (CA): Oxford University Press.
- Huizar, R. 2015. "Surviving privatization in the era of neo-liberalism: A case study of Mexico's oil company (PEMEX)." *The Extractive Industries and Society*, 2(2), 339-351.
- Hwang, In-Woon. 2003. *Personalized Politics: the Malaysian State Under Mahathir*. Singapore: Institute of Southeast Asian Studies.
- Hwok-Aun, Lee. 2007. "Industrial Policy and Inter-Ethnic Redistribution in Malaysia: Industrial Development and Equity Ownership, 1975-97." In *Malaysian Industrial Policy*. Edited by Jomo K.S. Singapore: National University of Singapore.
- IBP, 2015. *Public Policies Proposal for Socioeconomic Development Through Investments in Exploration and Production Offshore – Final Report 2015*. Rio de Janeiro: IBP/Bain & Company.
- IEA. 2005. *World Energy Outlook 2005*. Paris: OECD.
- IEA. 2008. *World Energy Outlook 2008*. Paris: OECD.
- IEA. 2012. *Medium-Term Oil Market Report 2012*. Paris: OECD/IEA.
- IEA. 2013. *World Energy Outlook 2013*. Paris: OECD.
- IEA. 2015. *Oil Market Report (13 October 2015)*. Paris: OECD.
- IEA. 2015. *World Energy Outlook 2015*. Paris: OECD/IEA.
- IMP. 2008. *Aportaciones del Institute Mexico de Petróleo a la Industria Petrolera Nacional (1965-2008)*. México (DF): Instituto Mexicano del Petróleo.
- Inman, Mason. 2016. *The Oracle of Oil: A Maverick Geologist's Quest for a Sustainable Future*. New York: W.W. Norton & Company, Inc..
- Inkpen, Andrew and Michael H. Moffett. 2011. *The Global Oil & Gas Industry: Management, Strategy & Finance*. Tulsa, OK: PennWell Corporation.
- International Budget Partnership (IBP). 2015. *Open Budget Survey 2015*. Washington (DC): International Budget Partnership.
- Jahn, Frank; Mark Cook, and Mark Graham. 2008. *Hydrocarbon Exploration and Production (2nd Edition)*. Amsterdam: Elsevier.

- Jayaseelan, Risen. 2017. "Consolidation in oil industry not happening fast enough." *The Star*, 02-22-2017. Available at: <http://www.thestar.com.my/business/business-news/2017/02/22/consolidation-not-happening-fast-enough/>
- Johnson, Simon, and Todd Mitton. 2003. "Cronyism and capital controls: evidence from Malaysia." *Journal of Financial Economics* 67.2: 351-382.
- Johnston, Daniel. 2003. *International Exploration Economics, Risk, and Contract Analysis*. Tulsa, OK: PennWell Corporation.
- Johnston, Daniel. 2008. "Changing fiscal landscape." *The Journal of World Energy Law & Business* 1.1: 31-54.
- Jomo K. S. 1999. "Development Planning in Malaysia: A Critical Appraisal." In *Political Economy of Development in Malaysia*. Edited by B.N. Ghosh and Muhammad Syuriki Salleh. Kuala Lumpur: Utusan Publications & Distributors Sdn. Bhd.
- Jomo, K. S. 1989. "Malaysia's New Economic Policy and national unity." *Third World Quarterly* 11.4 (1989): 36-53.
- Jomo, K. S. 2004. *The new economic policy and interethnic relations in Malaysia*. Geneva: UNRISD.
- Jomo, K. S. 2007. "Preface" in *Malaysian Industrial Policy*. Edited by Jomo K.S. Singapore: National University of Singapore.
- Kaiser, Mark J. and Brian F. Snyder. 2013. *The Offshore Drilling Industry and Rig Construction in the Gulf of Mexico*. London: Springer.
- Kang, David. 2002. *Crony Capitalism: Corruption and Development in South Korea and the Philippines*. Cambridge: Cambridge University Press.
- Karl, Terry Lynn. 1997. *The paradox of plenty: oil booms and petro-states*. Berkeley: University of California Press.
- Karl, Terry Lynn. 2007. "Ensuring fairness: the case for a transparent fiscal social contract." In *Escaping the Resource Curse*. Edited by Macartan Humphreys, Jeffrey D. Sachs, and Joseph E. Stiglitz, 256-285. New York: Columbia University Press.
- Knight, Frank. 1921. *Risk, Uncertainty, and Profit*. Boston: Hart, Schaffner & Marx.
- Kolstad, I., & Wiig, A. 2009. "It's the rents, stupid! The political economy of the resource curse." *Energy Policy*, 37(12), 5317–5325. doi:10.1016/j.enpol.2009.07.055
- Krehbiel, Keith. 1998. *Pivotal Politics: A Theory of U.S. Lawmaking*. Chicago: University of Chicago Press.
- Krueger, A. 1974. "The political economy of the rent-seeking society." *The American Economic Review*, Vol. 64, No. 3 (Jun., 1974), pp. 291-303.
- Kupfer, David, João Carlos Ferraz, and Felipe Silveira Marques. 2013. "The Return of Industrial Policy in Brazil." In *The industrial policy revolution I - the role of government beyond ideology*. Edited by Joseph E. Stiglitz and Justin Yifu Lin, editors. New York: Palgrave Macmillan.
- Kurtz, M. J., & Brooks, S. M. 2011. "Conditioning the "Resource Curse": Globalization, Human Capital, and Growth in Oil-Rich Nations." *Comparative Political Studies*, 44(6), 747–770.
- Lajous, Adrián. 2009. "The governance of Mexico's Oil Industry" in *No growth without equity? : inequality, interests and competition in Mexico*, edited by Santiago Levy and Michael Walton. Washington: The World Bank.
- Lajous, Adrián. 2014. *La Industria Petrolera Mexicana: Estrategias, Gobierno y Reformas*. México (DF): Fondo de Cultura Económica.
- Leahy, Joe. 2011. "Brazil: Platform for Growth." *Financial Times*, March 15, 2011.
- Lee, Eugene Thean Hock. 2013. *Scope For Improvement: Malaysia's oil and gas sector*. Available: <http://refsa.org/wp/wp-content/uploads/2013/07/OG-Scoping-Report-Malaysia-final-20130701.pdf>.
- Leffler, William L., Richard Pattarozzi and Gordon Sterling. 2011. *Deepwater petroleum exploration and production (2nd ed)*. Tulsa, OK: PennWell Corporation.

- Levitsky, S., & Murillo, M. V. 2013. "Building Institutions on Weak Foundations." *Journal of Democracy*, 24(2), 93–107. doi:10.1353/jod.2013.0031
- Levy, Santiago and Michael Walton. 2009. "Equity, Competition, and Growth in Mexico: An Overview" in *No growth without equity? : inequality, interests and competition in Mexico*, edited by Santiago Levy and Michael Walton. Washington: The World Bank.
- Leyva, M. A. L. 2015. "El episodio reformista en México (2012-2014): explorando las razones del cambio en la segunda alternancia." *Estudios Políticos*, 35, 61–85.
- Lima-de-Oliveira, Renato. 2016. "Resource-Led Industrial Development in the O&G Supply Chain: The Case of Brazil." *MIT-IPC Working Paper 16-002*. Available at: <http://ipc.mit.edu/sites/default/files/documents/16-002.pdf>
- Lin, Justin Yifu. 2012. *New Structural Economics: A Framework for Rethinking Development and Policy*. Washington (DC): The World Bank.
- Lipjhart, Arend. 2008. *Thinking About Democracy: Power Sharing and Majority Rule in Theory and Practice*. New York: Routledge.
- Lloyd's. 2014. *The Lloyd's Register Energy Oil And Gas Technology Radar An assessment of the sector's innovation trends and drivers*. Accessed on 3/10/2016. Available at http://www.longituderesearch.com/wp-content/uploads/2014/10/The_Lloyd_s_Register_Energy_Oil_And_Gas_Technology_Radar.pdf
- Lopez, Leslie. 2012. "Petronas: reconciling tensions between company and state." In *Oil and Governance: State-owned Enterprises and the World Energy Supply*. Edited by David G. Victor, David R. Hults, and Mark C. Thurber. New York: Cambridge University Press.
- López Portillo, José. 1982. "Sexto Informe de Gobierno del presidente José López Portillo." Available from http://www.biblioteca.tv/artman2/publish/1982_73/Sexto_Informe_de_Gobierno_del_presidente_Jos_L_pez_1221.shtml
- Loyola Díaz, Rafael and Liliana Martínez Pérez. 1994. "The effects on Labor of the Restructuring of Petróleos Mexicanos." In *Regional Integration and Industrial Relations in North America*. Edited by Maria Lorena Cook and Harry C. Katz. Ithaca, NY: ILR Press / Cornell University.
- Lucas, Luiz Paulo Vellozo. 2013. "A derrota de um modelo de sucesso." In *Petróleo: Reforma e Contrarreforma do Setor Petrolífero Brasileiro*. Edited by Fábio Giambiagi and Luiz Paulo Vellozo Lucas. Rio de Janeiro: Elsevier.
- Lula da Silva, Luiz Inácio. 2008. "Discurso do Presidente da República, Luiz Inácio Lula da Silva, na cerimônia de início do corte de aço para construção dos dez primeiros petroleiros." Available at: http://www.biblioteca.presidencia.gov.br/presidencia/ex-presidentes/luiz-inacio-lula-da-silva/discursos/2o-mandato/2008?b_start:int=100
- Lula da Silva, Luiz Inácio. 2009. "Discurso do Presidente da República Luiz Inácio Lula da Silva, no ato de anúncio da proposta de um novo modelo regulatório para a exploração das jazidas do pré-sal." Available at: <http://www.biblioteca.presidencia.gov.br/presidencia/ex-presidentes/luiz-inacio-lula-da-silva/discursos/2o-mandato/2009/31-08-2009-discurso-do-presidente-da-republica-luiz-inacio-lula-da-silva-no-ato-de-anuncio-da-proposta-de-um-novo-modelo-regulatorio-para-a-exploracao-das-jazidas-do-pre-sal/view>
- Luong, Pauline Jones, and Erika Weinthal. 2010. *Oil is not a Curse: Ownership Structure and Institutions in Soviet Successor States*. New York: Cambridge University Press.
- Magalhães, Roberto, Helio Guedes, and Wellington Vasconcellos. 2011. *Conteúdo Local aplicado ao setor de Óleo e Gás no Brasil*. Rio de Janeiro: ONIP.
- Magaloni, Beatriz. 2005. "The Demise of Mexico's One-Party Dominant Regime: Elite Choices and the Masses in the Establishment of Democracy." In *The Third Wave of Democratization in Latin*

- America: Advances and Setbacks*. Edited by Frances Hagopian and Scott P. Mainwaring. New York: Cambridge University Press.
- Mahathir. 1970. *The Malay Dilemma*. Kuala Lumpur: Federal Publications.
- Mahathir. 2011. *A Doctor in the House: The Memoirs of Tun Dr. Mahathir Mohamad*. Petaling Jaya: MPH.
- Mahdavi, P. 2014. "Why do leaders nationalize the oil industry? The politics of resource expropriation." *Energy Policy*, 75, 228–243. <http://doi.org/10.1016/j.enpol.2014.09.023>
- Malaysia Petroleum Resources Corporation (MPRC). 2015. *MPRC100 - 2014*. Kuala Lumpur: MPRC.
- Marcel, Valérie. 2006. *Oil Titans: National Oil Companies in the Middle East*. Baltimore: Brookings Institution Press.
- Martín del Campo, Alberto M., Manuel Bartlett Díaz, María de las Nieves Carbonell León, Federico J. Arce Navarro. 2015. *Marco constitucional para la soberanía nacional y energética*. Mexico (DF): Centro de Estudios Sociales y de Opinión Pública / Cámara de Diputados / LXII Legislatura.
- Mas'ud, A., Manaf, N. A. A., & Saad, N. 2014. "Comparison of Petroleum Fiscal Regimes Within Malaysia." *Petroleum Accounting and Financial Management Journal*, 33(2), 49-65.
- Matsuyama, K. 1992. "Agricultural productivity, comparative advantage, and economic growth." *Journal of Economic Theory*, 58(2), 317–334. [http://doi.org/10.1016/0022-0531\(92\)90057-0](http://doi.org/10.1016/0022-0531(92)90057-0)
- Maugeri, Leonardo. 2006. *The Age of Oil: The Mythology, History, and Future of the World's Most Controversial Resource*. Westport, CT: Praeger.
- Maugeri, Leonardo. 2012. "Oil: The Next Revolution" *Discussion Paper 2012-10*, Belfer Center for Science and International Affairs, Harvard Kennedy School, June 2012.
- McGlade, C., & Ekins, P. 2014. "Un-burnable oil: An examination of oil resource utilisation in a decarbonised energy system." *Energy Policy*, 64, 102–112.
- McMillan, J., & Zoido, P. 2004. "How to Subvert Democracy: Montesinos in Peru." *Journal of Economic Perspectives*, 18(4), 69–92. doi:10.1257/0895330042632690.
- Mehlum, H., Moene, K., & Torvik, R. 2006. "Institutions and the Resource Curse." *Society*, 116(2001), 1–20.
- Messmacher Linartas, Miguel. 2014. "Aspectos Tributarios de la Reforma Hacendaria." In *Reforma Social y Hacendaria: Finanzas Públicas para un México Incluyente*, edited by J. Edgar Braham, Adrián Gallardo, Roberto Esquivel. Mexico (DF): Fundación Colosio.
- Meyer, Lorenzo, and Isidro Morales. 1990. *Petróleo y nación (1900-1987): la política petrolera en México*. México (DF): Fondo de Cultura Económica.
- MME – Ministry of Mines and Energy. 2003. "Resolução n. 8, de 21 de julho de 2003." Available at: http://www.brasil-rounds.gov.br/arquivos/cnpe/rcnpe_082003.pdf
- Mommer, Bernard. 2002. *Global Oil and the Nation State*. New York: Oxford University Press.
- Moorthy, V. K. 1983. *Petronas: Its Corporate and Legal Status*. Kuala Lumpur (Malaysia): Malayan Law Journal Sdn. Bhd.
- Morais, José Mauro. 2013. *Petróleo em águas profundas – uma história tecnológica da Petrobras na exploração e produção offshore*. Brasília: IPEA.
- Morales, Eliezer and Juan José Dávalos López (eds). 2015. *Reforma para el saque: Foro Petróleo y Nación*. México (DF): Ediciones Proceso.
- Morales, Isidro. 1992. "Pemex during the 1960s and the Crisis in Self-Sufficiency." In *The Mexican Petroleum Industry in the Twentieth Century*. Edited by Jonathan C. Brown and Alan Knight. Austin, TX: University of Texas Press.
- Moreno, Martín. 2015. *Los Demonios del Sindicalismo Mexicano*. Querétaro, Mexico: Santillana Ediciones Generales.
- Moser, Robert G. 2009. "Electoral engineering in new democracies." In *Is democracy exportable?* Edited by Zoltan Barany and Robert G. Moser. New York (NY): Cambridge University Press.

- Muñoz Leos, Raúl. 2006. *Pemex en la Encrucijada: Recuento de una Gestión*. México (DF): Aguilar.
- Murphy, Kevin, Andrei Shleifer, and Robert W. Vishny. 1993. "Why is Rent Seeking So Costly to Growth?" *American Economic Review Papers and Proceedings*, 83, no. 2 (May 1993): 409-414.
- Musacchio, Aldo, and Sérgio G. Lazzarini. 2014. *Reinventing state capitalism: Leviathan in business, Brazil and beyond*. Cambridge, MA: Harvard University Press.
- National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. 2011. *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling*. Available at: <https://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf>
- Netto, Vladimir. 2016. *Lava Jato: O Juiz Sérgio Moro e os Bastidores da Operação que Abalou o Brasil*. Rio de Janeiro: Primeira Pessoa.
- Noh, Abdillah. 2014. "Historical Institutionalism and Economic Diversification: The Case of Malaysia." *Asian Social Science*, 10(9), p.40.
- Nolan, Peter A, and Mark Thurber 2012. "On the state's choice of oil company: risk management and the frontier of the petroleum industry." In *Oil and Governance: State-owned Enterprises and the World Energy Supply*. Edited by David G. Victor, David R. Hulst, and Mark C. Thurber. New York: Cambridge University Press.
- Nordas, H., E. Vatne, and P. Heum. 2003. "The Upstream Petroleum Industry and Local Industrial Development: A Comparative Study." *SNF Report 08/03*. Bergen (NO): Institute for Research in Economics and Business Administration.
- North, Douglas. 1990. *Institutions, Institutional Change and Economic Performance*. New York: Cambridge University Press.
- Novelo, Victoria. 1991. *La Difícil Democracia de Los Petroleros: Historia de un Proyecto Sindical*. México (DF): Ediciones el Caballito, S.A.
- Oliveira, Adilson. 2012. "Brazil's Petrobras: strategy and performance." In *Oil and governance: State-owned Enterprises and the World Energy Supply*. Edited by David G. Victor, David R. Hulst, and Mark Thurber, 515-556. Cambridge: Cambridge University Press.
- Olken, B. a., & Pande, R. 2012. "Corruption in Developing Countries." *Annual Review of Economics*, 4(1), 479–509.
- Ostrom, Elinor. 2005. *Understanding institutional diversity*. Princeton (NJ): Princeton University Press.
- OTC – Offshore Technology Conference. 2016. *OTC Distinguished Achievement Awards for Companies, Organizations, and Institutions*. Available at: <http://www.otcnet.org/Content/OTC-Distinguished-Achievement-Awards-for-Companies-Organizations-and-Institutions>
- Otta, Lu Aiko. 2017. "Governo reduz em 50% exigência de conteúdo local para setor de petróleo." *O Estado de São Paulo*, February 23, 2017.
- Ovadia, Jesse Salah. 2016a. *The Petro-Developmental State in Africa: Making Oil Work in Angola, Nigeria and the Gulf of Guinea*. London (UK): Hurst & Co.
- Ovadia, Jesse Salah. 2016b. "Local content policies and petro-development in Sub-Saharan Africa: A comparative analysis." *Resources Policy*, 49, 20–30. <http://doi.org/10.1016/j.resourpol.2016.04.003>
- Paduan, Roberta. 2016. *Petrobras: Uma História de Orgulho e Vergonha*. Rio de Janeiro: Editora Objetiva.
- Paus, E. a., & Gallagher, K. P. 2008. "Missing Links: Foreign Investment and Industrial Development in Costa Rica and Mexico." *Studies in Comparative International Development*, 43(1), 53–80. doi:10.1007/s12116-007-9016-2
- Pemex. 2009a. "Pemex and the Energy Reform." Available at: https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/attachments/CSIS_Conference_6_04_09%20%282%29.pdf

- Pemex. 2009b. "Estrategia de Petr leos Mexicanos para El Desarrollo de Proveedores, Contratistas y Contenido Nacional." Available at:
http://www.pemex.com/procura/Documents/desarrollo_proveedores_0907101.pdf
- Pemex. 2012. "Programa estrat gico tecnol gico 2013-2027." Accessed on 6/15/2016. Available at:
http://www.pemex.com/acerca/gobierno-corporativo/Documents/pet_2013-2027_121113.pdf
- Pemex. 2015a. "Mexico's Energy Reform & PEMEX as a State Productive Enterprise." Accessed on 6/15/2016. Available at: http://www.pemex.com/en/investors/investor-tools/Presentaciones%20Archivos/Investor%20Presentation_i_150127.pdf
- Pemex. 2015b. "Principales elementos del Plan de Negocios de Petr leos Mexicanos y sus empresas productivas subsidiarias 2016-2020." Accessed on 6/15/2016. Available at:
www.pemex.com/acerca/plan-de-negocios/Documents/eptn-pmx-eps_2016-2020.pdf
- Perrons, R. K. 2014. "How innovation and R&D happen in the upstream oil & gas industry: Insights from a global survey." *Journal of Petroleum Science and Engineering*, 124, 301–312.
- Petrobras, 2010. "Ind stria Nacional: o Pr -Sal como propulsor da ind stria brasileira – 5  F rum de Debates Brasilianas.Org." Presentation made by Jos  Sergio Gabrielli Azevedo (CEO). S o Paulo, 11/08/2010.
- Petrobras, 2013. *Retomada da Ind stria Naval e Offshore do Brasil 2003-2013-2020: vis o Petrobras*. Rio de Janeiro: Petrobras.
- Petrobras. 2015. *Management Report 2014*. Rio de Janeiro: Petrobras.
- Petrobras. 2015. *Relat rio de Tecnologia Petrobras 2014*. Rio de Janeiro: Petrobras.
- Petronas. 1992. *The Dulang Challenge: Carigali Comes of Age*. Kuala Lumpur (Malaysia): Petronas.
- Petronas. 2014a. "General Guidelines: Application for Petronas License and Registration." Available from
<http://www.petronas.com.my/partnering-us/licensing-registration/Documents/31DEC2014%20ENGLISH%20PANDUAN%20AM.PDF>
- Petronas. 2014b. *Annual Report 2013*. Kuala Lumpur: Petronas.
- Petronas. 2015. *Annual Report 2014*. Kuala Lumpur: Petronas.
- Petronas. 2016. *Annual Report 2015*. Kuala Lumpur: Petronas.
- Pew Research Center. 2014. "Mexican President Pe a Nieto's Ratings Slip with Economic Reform." Accessed June 10, 2016. <http://www.pewglobal.org/files/2014/08/Pew-Research-Center-Mexico-Report-FINAL-August-26-2014.pdf>
- Philip, George. 1982. *Oil and Politics in Latin America: Nationalist Movements and State Companies*. New York: Cambridge University Press.
- Pinto J nior, Helder Queiroz, Edmar Fagundes de Almeida, Jos  Vitor Bomtempo, Mariana Iooty, Ronaldo Goulart Bicalho. 2007. *Economia da Energia: Fundamentos Econ micos, Evolu o Hist rica e Organiza o Industrial*. Rio de Janeiro: Elsevier Editora.
- Pires, Adriano, and Rafael Schechtman. 2013. "Os resultados da reforma: uma estrat gia vencedora." In *Petr leo: Reforma e Contrareforma do Setor Petrol fero Brasileiro*, F bio Giambiagi and Luiz Paulo Vellozo Lucas, editors. Rio de Janeiro: Elsevier.
- Pires, Roberto, Alexandre Gomide, and Lucas Amaral. 2013. "A Ver Navios? A Revitaliza o da Ind stria Naval no Brasil Democr tico." *Texto para Discuss o 1864*. Rio de Janeiro: IPEA.
- Playfoot, Jim, Phil Andrews, Simon Augustus. 2015. *Education and Training for the Oil and Gas Industry*. Amsterdam: Elsevier/Getenergy Intelligence.
- Porto, Geciane, Lenita Turchi and Priscila Rezende. 2013. "Radiografia das parcerias entre PETROBRAS e as ICTs Brasileiras: Uma an lise a partir da  tica dos coordenadores de projetos tecnol gicos." In *Impactos tecnol gicos das parcerias da Petrobras com universidades, centros de pesquisa e firmas brasileiras*. Edited by Lenita Maria, Fernanda De Negri, and Jo o Alberto De Negri. Bras lia: IPEA.

- Pratt, Joseph A., Tyler Priest, and Christopher James Castaneda. 1997. *Offshore pioneers: Brown & Root and the history of offshore oil and gas*. Houston (TX): Gulf Publishing Company.
- Prebisch, Raúl. 1950. *The Economic Development of Latin America and its Principal Problems*. Lake Success (NY): United Nations Department of Social Affairs.
- Priest, Taylor. 2007. "Extraction Not Creation: The History of Offshore Petroleum in the Gulf of Mexico," *Enterprise & Society* Vol. 8, No. 2 (June 2007): 227-267
- Priest, Tyler. 2016. "Petrobras in the History of Offshore Oil." In *New Order and Progress: Development and Democracy in Brazil*. Edited by Ben Ross Schneider, 53-77. New York: Oxford University Press.
- Prominp. 2016. "Qualificação no Prominp." Accessed April 15, 2016.
http://www.prominp.com.br/prominp/pt_br/conteudo/qualificacao-no-prominp.htm
- Przeworski, A. 2004. "Institutions Matter?" *Government and Opposition*, 39(4), 527–540.
doi:10.1111/j.1477-7053.2004.00134.x
- Puthuchery, Mavis. 2005. "Introduction: Contextualising Malaysian Elections." In *Elections and Democracy in Malaysia*. Edited by Mavis Puthuchery and Norani Othman. Bangi: UKM.
- Quintans, Luiz Cesar. 2010. *Direito do Petróleo – Conteúdo Local*. Rio de Janeiro: IBP/Freitas Bastos Editora.
- Randall, Laura. 1989. *The Political Economy of Mexican Oil*. New York: Praeger.
- Randall, Laura. 1993. *The Political Economy of Brazilian Oil*. Westport, CT: Praeger.
- Rappel, Eduardo. 2011. "A exploração econômica do pré-sal e os impactos sobre a indústria brasileira de petróleo." In *Mar de Riqueza, Terra de Contrastes: O Petróleo no Brasil*. Edited by Rosélia Piquet. Rio de Janeiro: Maud Editora/Faperj.
- Raymond, Martin S, and William L. Leffler. 2006. *Oil and Gas Production*. Tulsa (OK): Penwell.
- Razali, Che Hamdan Che Mohd. 2014. "Kuala Nerus, Terengganu: New Malay Politics?" In *Electoral dynamics in Malaysia: Findings from the Grassroots*. Edited by Meredith L. Weiss. Petaling Jaya: Strategic Information and Research and Development Centre.
- Real y Aguilera, José Alfonso Suárez (eds.). 2008. *El Petróleo en la Historia y la Cultura de México*. México (DF): Grupo Parlamentaria del PRD em la LX Legislatura.
- Resource Governance Index (RGI). 2013. *The 2013 Resource Governance Index*. Available at:
http://www.resourcegovernance.org/sites/default/files/rgi_2013-webreport.pdf
- Reuters. 2015. "Pemex and union agree to pension reform, unlocking debt relief." Available at:
<http://www.reuters.com/article/mexico-pemex-idUSL1N13702K20151112>
- Robinson, J. A., & Torvik, R. 2009. "A political economy theory of the soft budget constraint." *European Economic Review*, 53(7), 786–798. doi:10.1016/j.eurocorev.2009.02.006
- Robinson, J., Torvik, R., & Verdier, T. 2006. "Political foundations of the resource curse." *Journal of Development Economics*, 79(2), 447–468. doi:10.1016/j.jdeveco.2006.01.008
- Robinson, Mark L. 2014. *Marketing Big Oil: Brand Lessons from the World's Largest Companies*. New York: Palgrave Macmillan.
- Rodrik, Dani. 2000. "Institutions for high-quality growth: What they are and how to acquire them." *Studies in Comparative International Development*, 35(3), 3–31. doi:10.1007/BF02699764
- Rodrik, Dani. 2007. *One Economics, Many Recipes: Globalization, Institutions, and Economic Growth*. Princeton: Princeton University Press.
- Romo, Daniel. 2015. "The Cantarell Oil Field and the Mexican Economy," *Problemas del Desarrollo - Revista Latinoamericana de Economía*, Volume 47, Number 184, January-March 2016.
- Ross, M. L. 2001. "Does oil hinder democracy?" *World Politics*, 53, 325-3611.
- Ross, M. L. 2008. "Oil, Islam, and women." *American Political Science Review*, 102, 107-123.
- Ross, M. L. 2012. *The Oil Curse: How Petroleum Wealth Shapes the Development of Nations*. Princeton, NJ: Princeton University Press.

- Ross, M. L. 2015. "What Have We Learned about the Resource Curse?" *Annual Review of Political Science*, 18(1), 239–259. <http://doi.org/10.1146/annurev-polisci-052213-040359>
- Rousseff, Dilma Vana. 2013. "Discurso da presidenta da República, Dilma Rousseff, durante cerimônia de conclusão das obras da P-62 no Estaleiro Atlântico Sul - Ipojuca/PE." Accessed January 20, 2017. <http://www2.planalto.gov.br/acompanhe-o-planalto/discursos/discursos-da-presidenta/discorso-da-presidenta-da-republica-dilma-rousseff-durante-cerimonia-de-conclusao-das-obras-da-p-62-no-estaleiro-atlantico-sul>
- Ryggevik, Helge. 2014. *Construindo uma indústria nacional de petróleo offshore*. Rio de Janeiro: Elsevier.
- Sacchet, Teresa, and Bruno Wilhelm Speck. 2012. "Financiamento Eleitoral, Representação Política E Gênero: Uma Análise Das Eleições de 2006." *Opinião Pública* 18 (1): 177–97. doi:10.1590/S0104-62762012000100009.
- Sachs, Jeffrey, and A. M. Warner. 1995. "Natural Resource Abundance and Economic Growth." *National Bureau of Economic Research Working Paper*, no. 5398, December. National Bureau of Economic: Cambridge, MA
- Sachs, Jeffrey, and A. M. Warner. M.1997. "Natural Resource Abundance and Economic Growth – revised version." *Working Paper*, Harvard University.
- Sachs, Jeffrey. 2007. "How to handle the macroeconomics of oil wealth.", in *Escaping the Resource Curse*, edited by Macartan Humphreys, Jeffrey D. Sachs, and Joseph E. Stiglitz, 172-193. New York: Columbia University Press.
- Samuels, David. 2001. "Money, Elections, and Democracy in Brazil." *Latin American Politics and Society* 43 (2): 27–48. doi:10.2307/3176970.
- Sanchez, R. A. 1983. "Oil boom, a blessing for Mexico?" *GeoJournal* 7.3: 229-246.
- Sarmidi, T., Law, S. H., & Jafari, Y. 2014. "Resource Curse: New Evidence on the Role of Institutions." *International Economic Review*, 28(1), 191–206. doi:10.1080/10168737.2013.787110
- Schneider, Ben Ross. 2013. *Hierarchical capitalism in Latin America: Business, Labor, and the Challenges of Equitable Development*. New York: Cambridge University Press.
- Schneider, Ben Ross. 2015a. *Designing Industrial Policy in Latin America*. New York: Palgrave MacMillan.
- Schneider, Ben Ross. 2015b. "The developmental state in Brazil: comparative and historical perspectives." *Revista de Economia Política*, 35(138), 114–132.
- Schumpeter, Joseph A. 1942 (2008). *Capitalism, Socialism and Democracy*. Reprint, New York: Harper Perennial Modern Thought.
- Secretaría de Energía (SENER). 2008. *Diagnóstico: Situación de Pemex*. México (DF): Sener and Pemex.
- Secretaría de Energía (SENER). 2015. *Plan Quinquenal de Licitaciones para la Exploración y Extracción de Hidrocarburos 2015-2019: Un Proceso Participativo*. México (DF): Sener and Pemex.
- Secretaría de Programación y Presupuesto (SPP). 1980. *La Industria Petrolera en México*. México (DF): SPP and Petroleos Mexicanos (PEMEX).
- Segal, P. 2012. "How to spend it: Resource wealth and the distribution of resource rents." *Energy Policy*, 51, 340–348.
- Sete Brasil. 2016. "Profile and History." *Sete Brasil*. Accessed March 30, 2016. <http://ir.setebr.com/static/enu/perfil-e-historico.asp?idioma=enu>
- Shleifer, Andrei and Robert W. Vishny. 1993. "Corruption." *The Quarterly Journal of Economics*, 108.3 (August): 599-617.
- Shleifer, Andrei and Robert W. Vishny. 1998. *The Grabbing Hand: Government Pathologies and Their Cures*. Cambridge, MA: Harvard University Press.
- Shuen, A., Feiler, P. F., & Teece, D. J. 2014. "Dynamic capabilities in the upstream oil and gas sector: Managing next generation competition." *Energy Strategy Reviews*, 3(C), 5–13.

- Siddayao, Corazón Morales. 1978. *The Off-shore Petroleum Resources of South-East Asia: Potential Conflict Situations and Related Economic Considerations*. Singapore: Oxford University Press.
- Siddiqi, Afreen, and Laura Diaz Anadon. 2017. "Science and Engineering Research Collaborations: Patterns of Integration and Extension in the GCC." In *Science and Technology Development in the Gulf States: Economic Diversification Through Regional Collaboration*. Edited by Afreen Siddiqi and Laura Diz Anadon. Berlin: Gerlach Press.
- Sikkink, Kathryn. 1991. *Ideas and Institutions: Developmentalism in Brazil and Argentina*. Ithaca: Cornell University Press.
- Silva, M.M., 2014. "Tributação na indústria da construção naval brasileira: peso dos tributos e sobre preço de navio-tanque e plataforma offshore." In *Ressurgimento da indústria naval no Brasil (2000-2013)*. Edited by Carlos Alvares da Silva Campos Neto and Fabiano Mezadre Pompermayer. Brasília: 2014.
- Simmons, J. W. 2016. "Resource Wealth and Women's Economic and Political Power in the U.S. States." *Comparative Political Studies*, 49, 115–152. doi:10.1177/0010414015597510
- Sinaval. 2014. Mapa dos Estaleiros no Brasil. Available at: http://sinaval.org.br/wp-content/uploads/Mapa_Brasil_Dez14.pdf
- Slater, Dan. 2010. *Ordering Power: Contentious Politics and Authoritarian Leviathans in Southeast Asia*. New York: Cambridge University Press.
- Slater, Dan and Ziblatt, D. 2013. "The Enduring Indispensability of the Controlled Comparison." *Comparative Political Studies* 46, no. 10: 1301-1327.
- Smith, Benjamin. 2007. *Hard times in the lands of plenty: oil politics in Iran and Indonesia*. Ithaca: Cornell University Press.
- Smith, Benjamin. 2012. *Measuring the Resource Curse: Revisiting the Politics of Oil Wealth*. Working Paper.
- Smith, Peter Seaborn. 1976. *Oil and Politics in Modern Brazil*. Toronto: The Macmillan Company.
- Smith, Vernon L. 1998. "The two faces of Adam Smith." *Southern Economic Journal* (1998): 2-19.
- Soong, Kua Kia. 2007. *May 13: Declassified Documents on the Malaysian Riots of 1969*. Petaling Jaya: Suaram Komunikasi.
- Statoil. 2017. Annual Report and Form 20-F 2016. Available at: <https://www.statoil.com/content/dam/statoil/documents/annual-reports/2016/statoil-2016-annualreport-20-F.pdf>
- Stevens, P., & Dietsche, E. 2008. "Resource curse: An analysis of causes, experiences and possible ways forward." *Energy Policy*, 36(1), 56–65. doi:10.1016/j.enpol.2007.10.003
- Stevens, P., 2006. "'Resource curse' and how to avoid it?" *The Journal of Energy and Development* 31 (1).
- Stiglitz, Joseph. 1993. *Economics*. New York: W.W. Norton & Company.
- Stiglitz, Joseph. 2007. "What is the role of the state?" In *Escaping the Resource Curse*. Edited by Macartan Humphreys, Jeffrey D. Sachs, and Joseph E. Stiglitz, 23-52. New York: Columbia University Press.
- Stiglitz, Joseph E., Justin Yifu Lin and Célestin Monga. 2013. "Introduction: The Rejuvenation of Industrial Policy" in *The Industrial Policy Revolution I - The Role of Government Beyond Ideology*. Edited by Joseph E. Stiglitz and Justin Yifu Lin. New York: Palgrave Macmillan.
- Stojanovski, Ognen. 2012. "Handcuffed: an assessment of Pemex's performance and strategy." In *Oil Governance: State-owned Enterprises and the World Energy Supply*. Edited by David G. Victor, David R. Hults, and Mark Thurber. Cambridge: Cambridge University Press.

- Sugiyama, N., & Hunter, W. 2013. "Whither Clientelism? Good Governance and Brazil's "Bolsa Família" Program." *Comparative Politics*, 46(1), 43-62.
- Thu, Goh Sing, D. W. Heacock, D.E. Loveless. 1983. "Exploration, development, and reservoir engineering studies for the Tapis Field Offshore Peninsular Malaysia." *Journal of Petroleum Technology*, 35(06), 1-051.
- Thurber, Mark C.; David R. Hults, and Patrick R P Heller. 2011. "Exporting the 'Norwegian Model': The Effect of Administrative Design on Oil Sector Performance." *Energy Policy* 39 (9). Elsevier: 5366–78. doi:10.1016/j.enpol.2011.05.027.
- Tordo, Silvana, Johnston, David; Johnston, Daniel. 2009. "Petroleum Exploration and Production Rights: Allocation Strategies and Design Issues." *World Bank Working Paper* no. 179. Washington: The World Bank.
- Tordo, Silvana, Brandom S. Tracy and Noora Arfaa. 2011. "National oil companies and value creation." *World Bank Working Paper* 218.
- Tordo, Silvana, Warner, M., Manzano, O. and Anouti, Y., 2013. *Local Content Policies in the Oil and Gas Sector*. Washington (DC): World Bank.
- Treisman, D. 2007. "What Have We Learned About the Causes of Corruption from Ten Years of Cross-National Empirical Research?" *Annual Review of Political Science*, 10(1), 211–244.
- Tribunal de Contas da União (TCU). 2014. *Acórdão Nº 2764/2014 - Requerimento de auditoria para avaliar os gastos da Petrobras na construção do petroleiro João Cândido e outras irregularidades relacionadas ao empreendimento*. Brasília (DF): TCU.
- Tribunal de Contas da União (TCU). 2016. *Acórdão Nº 3072/2016 - Auditoria operacional. Avaliação da Sistemática Vigente da Política de Conteúdo Local*. Brasília (DF): TCU.
- Tsebelis, George. 1995. "Decision Making in Political Systems: Veto Players in Presidentialism, Parliamentarism, Multicameralism, and Multipartyism," *British Journal of Political Science*, 25 (3), July.
- Tsui, K. K. 2011. "More Oil, Less Democracy: Theory and Evidence from Crude Oil Discoveries." *The Economic Journal*, 121(551), 89–115. doi:10.1111/j.1468-0297.2009.02327.x.
- Tullock, Gordon. 1967. "The welfare costs of tariffs, monopolies, and theft." *Economic Inquiry* 5.3 (1967): 224-232.
- Tullock, Gordon. 1990. "The costs of special privilege." In *Perspectives on Positive Political Economy*, edited by James E. Alt and Kenneth A. Shepsel. New York: Cambridge University Press.
- Tun Razak, Datuk Seri Najib. 2010. "Speech by Prime Minister Datuk Seri Najib Tun Razak during the launch of the New Economic Model on March 30, 2010." Accessed at March 15, 2017. <http://www.thestar.com.my/story/?file=%2F2010%2F3%2F30%2Fneweconomicmodel%2F20100330113457>
- Turchi, Lenita Maria, Fernanda De Negri, and João Alberto De Negri. 2013. *Impactos tecnológicos das parcerias da Petrobras com universidades, centros de pesquisa e firmas brasileiras*. Brasília: IPEA.
- Universiti Teknologi Petronas (UTP). 2017. About Us. Available from: <https://www.utp.edu.my/The%20University/About-Us/SitePages/Home.aspx>.
- US Department of Justice (US DOJ). 2010. *Horizontal Merger Guidelines*. Available at: <https://www.justice.gov/sites/default/files/atr/legacy/2010/08/19/hmg-2010.pdf>
- Valle, Sabrina. 2013. "Petrobrás vai à China para evitar atraso na produção. Fornecedor local reclama." *O Estado de São Paulo*, February 25, 2013.
- Van Meurs P. 2008. *Government take and petroleum fiscal regimes. Report for Kurdistan Regional Government of Iraq*. Available at: http://www.iaccidatabase.com/PDF_files/Government%20Take%20an3645/Government_Take_and_Petroleum_Fiscal_Regimes__2008_06_30_h14m7s53.doc.

- Verleger, Philip K. 1993. *Adjusting to Volatile Energy Prices*. Washington, D.C.: Institute for International Economics.
- Vernon, Raymond. 1971. *Sovereignty at Bay: The Multinational Spread of US Enterprises*. New York: Basic Books.
- Victor, D. G. 2013. "National Oil Companies and the Future of the Oil Industry." *Annual Review of Resource Economics*, 5(1), 445–462.
- Ville, S., and Wicken, O. 2012. "The dynamics of resource-based economic development: evidence from Australia and Norway." *Industrial and Corporate Change*, 22(5), 1341–1371. doi:10.1093/icc/dts040.
- Wad, P. and Chandran Govindaraju. 2011. "Automotive industry in Malaysia: an assessment of its development." *International Journal of Automotive Technology and Management*, 11(2), pp.152-171.
- Wain, Barry. 2012. *Malaysian Maverick: Mahathir Mohamad in Turbulent Times*. New York: Palgrave Macmillan.
- Warner, Michael. 2011. *Local Content in Procurement: Creating Local Jobs and Competitive Domestic Industries in Supply Chains*. Sheffield: Greenleaf Publishing Limited.
- Warshaw, C., 2012. "The political economy of expropriation and privatization of national oil companies." In *Oil and Governance: State-owned Enterprises and the World Energy Supply*. Edited by David G. Victor, David R. Hults, and Mark Thurber. Cambridge: Cambridge University Press.
- Weiner, R. 2006. "Do Birds of a Feather Flock Together - Speculator Herding in the World of Market." *RFF Discussion Paper* 06-31. Retrieved from <http://link.springer.com/article/10.1007/S12110-013-9174-Z>
- Weiss, Meredith L., ed. 2014. *Electoral dynamics in Malaysia: Findings from the Grassroots*. Petaling Jaya: Strategic Information and Research and Development Centre.
- Whittle, A. P. and G. A. Short. 1978. "The Petroleum Geology of the Tembungo Field, East Malaysia." *Offshore South East Asia Conference*. 21-24 February 1978.
- Wolthers, Gabriela and Daniel Bramatti. 1995. "Governistas conseguem 364 votos contra domínio da Petrobrás; para FHC, interesse nacional está preservado." *Folha de São Paulo*, 06/08/1995. Available at: http://almanaque.folha.uol.com.br/brasil_08jun1995.htm
- Wright, Gavin, and Jesse Czelusta. 2004. "The Myth of the Resource Curse." *Challenge* (05775132) 47, no. 2: 6-38.
- Wright, J., Frantz, E., & Geddes, B. 2015. "Oil and Autocratic Regime Survival." *British Journal of Political Science*, 45(02), 287–306. doi:10.1017/S0007123413000252
- Yergin, Daniel. 1991. *The Prize: The Epic Quest for Oil, Money, and Power*. New York: Simon and Schuster.
- Yusof, Zainal Aznam. 2011. "The Developmental State Malaysia" in *Plundered Nations? Successes and Failures in Natural Resource Extraction*, edited by Paul Collier and Anthony J. Venables. New York: Palgrave MacMillan.
- Zahlan, A. B. 2012. *Science, Development, and Sovereignty in the Arab World*. New York: Palgrave Macmillan.
- Zucco, C. 2013. "When Payouts Pay Off: Conditional Cash Transfers and Voting Behavior in Brazil 2002-10." *American Journal of Political Science*, 57(4), 810–822. <http://doi.org/10.1111/ajps.12026>
- Zuckerman, Gregory. 2013. *The Frackers: The Outrageous Inside Story of the New Billionaire Wildcatters*. New York: Penguin.
- Zylberstajn, David and Sonia Agel. 2013. "A reforma do setor de petróleo de 1997: racionalidade, concepção e implementação." In *Petróleo: Reforma e Contrarreforma do Setor Petrolífero Brasileiro*. Edited by Fábio Giambiagi and Luiz Paulo Vellozo Lucas. Rio de Janeiro: Elsevier.