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Oil Sector Performance and Institutions:

*The Case of Latin America**

Lenin H. Balza[†] Ramón Espinasa[‡]

Abstract

Oil producers small enough to be price takers without barriers to investment or production should have reacted positively to the fourfold price increase after 2002. The seven largest Latin American oil producers reacted to this permanent price signal in different ways. Brazil, Colombia and Peru reacted positively, increasing investment and production. However, Argentina, Ecuador, Mexico and Venezuela did not react to the positive market signal, and instead paradoxically reduced oil production. We argue that these different responses among LA oil producers to the quantum leap in the price level over the last decade can be explained by differences in the institutional frameworks governing the oil sector in each country, and thus by each country's incentives to invest in response to changing price signals.

Keywords: Institutions; Oil Production; Oil Prices; Latin America

JEL classification: K20, Q40, Q41, Q48, O54

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Introduction

Based on their performance over the last seventeen years, it is possible to sort the seven largest Latin American oil-producing countries into two groups. Since the individual supply produced by each of these countries is small enough for all of the countries to be considered price takers, it would be expected that oil activity, as measured by oil output and number of drilling rigs, would increase following the permanent quantum leap in prices after 2002. However, the reaction was not positive and homogeneous in all oil-producing countries in the region. Three countries in effect permanently increased drilling activity and production: Brazil, Colombia and Peru. In contrast, in Mexico, Venezuela, Ecuador and Argentina, drilling activity remained stagnant and production declined over the last decade.

We shall argue in this paper that the dissimilar behavior of these two groups of countries is related to characteristics of the institutional framework that regulates investment, activity and production. Countries in the first group have regulatory frameworks with similar features: they are open to private investment side by side and in competition with state-owned companies, they are open to public scrutiny, land assignment and operation fall under the purview of an independent regulatory agency, and they have stable distributional and operational rules. Countries in the second group also have institutional features in common: production is under direct monopoly control by a state-owned company, there is some degree of discretionary government intervention in both distribution of revenue and management of the company, and the oil sector is closed to competition and public scrutiny. These different features explain the countries' dissimilar responses to market price signals.

The paper is organized into two main parts. The first provides an analytical framework for discussing the relationship between institutions and performance in oil countries. We highlight the role of the state as owner of oil reservoirs. In the second part, we analyze empirical evidence from the seven largest Latin American oil producers with regard to investment, production and institutional changes over the last two decades. We group these countries together into two families with similar institutional features and similar reactions to market signals. We show that the different reactions to the quantum leap in prices after 2002 can be explained by the incentives to invest in response to market signals that are imbedded in the institutions governing the oil sector. Finally, we summarize the main findings of the paper.

1 Analytical Framework

The analytical framework is divided into three sections. The first defines performance and institutions and highlights the state's singular role as owner of hydrocarbon reserves in oil-producing countries, with responsibility for regulating their development using two sets of interacting institutions, fiscal and operational. The second section defines sources of rent in oil production and describes fiscal institutions designed to capture economic rents in oil production. The second section analyzes the relationship between government take, investment and production. The third section describes the set of institutions through which the state regulates the development of its reserves. The way the state organizes the oil sector defines the industry's organization and affects the performance of the sector. In this third section of the analytical framework, we describe the main features of two sets of families that can be used to classify how the oil sector is organized worldwide. These families contain the set of seven Latin American oil countries under analysis.

A. Oil Sector Institutions: State ownership of reserves and fiscal and operational institutions

A1. Defining performance and institutions

We shall define national oil sector performance very narrowly, as the extent to which and the rate at which investment and production in the oil sector respond to market signals. In a rational economic world—without frictions or barriers to investment and with producers small enough to be price takers—there should be a causal relationship between prices and production via changes in investment in crude oil production. We therefore define good performance as a situation in which these three variables move in the same direction, whereas poor performance is defined as a situation in which investment and production show no reaction or move in a direction opposite to price movements.

The best proxy for investment in the oil sector is the number of active drilling rigs.[1] If we assume an oil-producing country small enough to be a price taker, it should be expected that the number of active drilling rigs would fluctuate with prices. Further,

[1] It is a well-known industry fact that the cost of rotatory equipment for well-drilling and completion represents around two-thirds of non-wage oil production expenditures. We are particularly thankful to Mr. Juan Szabo, former head of PDVSA Exploration and Production, for this insight.

assuming that a change in prices is perceived to be permanent, there will be a time lag between the price signal and a change in the number of active rigs, and thus actual variation in the production level.

In the case of a positive price signal leading to an increase in activity, there would be a delay due to availability of rigs and/or time required to bring drilling units to selected locations and then put into place the infrastructure required for the rig to begin drilling. The drilling process can take several weeks or even months before the selected geological objective is reached. There can be an additional delay between the end of the drilling process and the point at which crude oil enters the stream if additional transportation infrastructure is needed.

When a price signal is negative, some lead-time is required in order for the drilling process to end and for the rig to be dissembled. Crude oil prices will seldom be low enough that they fail to cover operational costs and lead to a shutdown in production. The fall in production following a drop in prices perceived to be permanent may be a consequence of the natural decline in production as the reservoir is exhausted; the drop in drilling activity does not compensate for pressure loss, and production comes off stream.

Response to price signals varies widely among oil countries small enough to behave as price takers. Assuming projects with similar technical characteristics, the reasons for these diverse responses might be largely related to institutional constraints to investment in the oil sector. How societies organize themselves to develop oil-bearing lands or similar resources is a starting point for understanding their performance in this industry.

Seminal works by North (1981) and Williamson (1985), as well as many others, show why institutions are important and how institutional change affects the performance of economies.[2] We shall define institutions in the classical sense expressed in the body of work by Douglass North as "the rules of the game." North (1994) defines institutions as "the humanly devised constraints that structure human interaction. They are made up of formal constraints (rules, laws and constitutions), informal constraints (norms of behavior, conventions and self-imposed codes of conduct) and their enforcement characteristics."

Many scholars have argued that institutions are at least partly endogenous. In fact, Acemoglu et al. (2001) suggest that institutions might not necessarily be exogenous,

[2]This literature was enriched by a good amount of empirical work across countries, which estimates the growth-promoting effects of well-run institutions.

and are instead a product of economic conditions as much as they are a cause. Both Acemoglu et al. (2001) and Rodrik et al. (2004) find that institutions have a large effect on economic performance.

A2. State Ownership of Reserves: Production and Oil Fiscal Revenue

With the exception of private oil-bearing lands in the United States, oil reservoirs in every country in the world are state-owned, including federal lands in the United States. Monopoly ownership of oil reserves gives the state the right to do the following: first, decide how and when such reserves are to be developed; and second, claim economic rents due to scarcity, quality, reservoir productivity and location. Such rents are not due to changes in industrial productivity but are intrinsic to the conditions of the natural resource and belong to the owner of the reserves. As such, the state has the first right to claim them.

The state has the sovereign right and obligation to administer use of the oil-bearing lands within its territory. The state can exercise its monopoly property rights on the reserves in two basic ways: first, by maintaining direct monopoly control of production through a state-owned company; and second, by maintaining indirect control through a ministry or a non-operating regulatory agency that administers the development of oil-bearing lands by private or state-owned operators.

The state also has the right to claim as specific oil revenue the rents that derive from the four sources to be developed below: scarcity, reservoir productivity, quality and location. The dual, sometimes contradictory, objectives of the state are, on the one hand, to obtain the maximum rent as owner of the natural resource and, on the other, to maximize wealth creation in the country through development of the oil reserves. At the margin, demanding too high a rent may prevent the development of the reserves, thus rendering null the achievement of both objectives, obtaining rent and creating wealth, as will be argued below.

B. Fiscal Institutions: Government Take and Production

As owner of the oil reserves the state has the first right to demand the economic rents that arise in crude oil production vis-à-vis a marginal producer setting the price. These rents are not due to increases in industrial productivity but are intrinsic to the natural resource. The state aims to capture such rents through different oil-specific levies over and above normal taxes. In this section, we first discuss the different sources of economic

rents inherent to oil production and analyze the main features of the oil rent–capturing mechanisms and how they may affect sector performance.

B1. Sources of Fiscal Revenues from Oil

As the owner of hydrocarbon reserves, the state has the right to claim for itself the economic rents from crude oil production, which come from four sources. The first of these is the economic rent caused by the relative scarcity of oil as a source of energy in the world market. Assuming competition in world energy markets, the magnitude of this rent from the supply side will depend on the cost of alternative sources of energy that compete with oil products in different final demand segments. In case of a non-competitive market, monopoly rents in oil production will depend on the degree of monopoly by the main world oil exporters. From the demand side, the magnitude of this rent will depend on how much consumers are prepared to pay to make use of this source of energy.[3]

The second source of rent arises from the natural conditions of the country's reservoirs, which, given a production technology, determine production costs. The magnitude of this rent will depend on the cost of production in marginal fields, using the same technology used to produce the same type of crude oil elsewhere. The lower the cost, given the same technology and oil quality, the larger the differential rent the owner state will have the right to claim compared to costlier reservoirs elsewhere in the world market.[4]

The third idiosyncratic source of rent in oil production comes from differences in the quality of crude oil. The viscosity of the oil and its sulfur and metal content will determine the costs of transforming it into a final product for consumption. The lighter the crude oil and the lower its content of impurities, the lower the transformation costs. These lower costs are not due to technology improvements, but are strictly due to the natural conditions of the crude oil. The rent due to differences in quality should accrue to the owner of the reserves.

Finally, there is a fourth source of rent determined by the geographical location of the reservoirs in relation to consumption markets. The closer the reservoirs and the lower the transportation costs, the higher the rent the state can demand as owner of the crude oil compared to more distantly located supply points.

[3]This is commonly referred to as Monopoly Rent or Absolute Rent in Marxian terms.
[4]This is commonly referred to as Ricardian Rent or Differential Rent in Marxian terms.

The four sources of rent outlined here are not determined by capital or labor productivity increases, but by the natural endowment of the country and, under property conditions established nearly everywhere in the world, the state has the right to capture these revenues.

B2. Government take

The state aims to capture these rents through three specific devices: royalty payments as a share of production; specific oil taxes as a share of profits over and above established commercial taxes; and an upfront down payment, either as a minimum requirement to gain access to the reserves if directly awarded by the government, or as a consequence of the bidding process among competing companies to gain access to the reserves. The government's revenue resulting from these three means of capturing rents is commonly referred to as the *government take* and is usually measured as a share of total revenue. All three devices have advantages and disadvantages. We shall discuss each one of them, and each will be evaluated on three parameters: complexity, accuracy and the potential for distortion of the investment.

1. Royalty Payment

Royalty payments are the oldest and most primitive form of rent capturing. At the same time, they are the simplest and most straightforward device for that purpose. A royalty consists of an agreed-upon share of production volume that is established before production commences. All that is needed for the calculation is the volume to be produced, because costs or profits, although taken into account for the initial royalty estimation, do not intervene in the actual calculations once the rate is set.

The simplicity of the device has its drawbacks, especially with regard to accuracy and the flexibility to accommodate changing circumstances. There are three particular cases in which the rigidity of the royalty mechanism distorts rent distribution and may lead to the closure of economically profitable reservoirs or lead to rent-capturing by the operator. First is in the event of large price fluctuations; second is in the case of changes in productivity or quality among reservoirs when the same rate is applied country-wide; and third is when marginal costs increase over time with lower marginal natural productivity in the same field under a fixed technology.

Royalty rate rigidity may affect both the resource owner and the producer. When prices increase sharply, a fixed royalty rate will be unable to maintain the government

take as a share of the operational surplus, since it is calculated as a share of total revenue and not the operational surplus, measured as total revenue minus operational costs. When prices increase, a growing share of that increase will be appropriated as profits by the operator when, by nature, this type of increase should accrue to the resource owner, if not entirely, at least as a growing share.

The same problem affects the operator when prices drop sharply, since a fixed royalty as a share of total revenue will squeeze profit margins proportionally more than the government take. The royalty take will act as an additional cost, squeezing the falling profit margin.

2. Specific Oil Taxes

A second, more modern and relatively sophisticated type of rent-capturing device is specific oil profit taxes. These are specific taxes or series of taxes, over and above regular income tax, which tax the economic rent resulting from any of the above discussed sources: scarcity, production costs, quality and location; which should accrue to the state owner in oil production.

In contrast to a royalty, oil profit taxes are applied to the surplus above costs. Thus the government take is proportional to gross profits and fluctuates with them. In this regard, it is a less distorting rent-capturing mechanism than royalty, which acts as an extra cost, with a disproportionate effect when surplus is low and a failure to capture rent when the surplus is high.

With specific oil profit taxes, the government take will move with the gross profits, avoiding the distortion of profitability after taxes. Profits will be affected by the tax rate applied to the operational surplus. The state owner and the operating company share the fluctuation in operational surplus and thus share the benefits of increases in rent and the risk of a rent decrease. The ideal rent-capturing mechanism would be a sliding scale rate that increases as the surplus increases, capturing rent for the owner that is greater than proportional to the actual increase in rent.

Compared to the mechanism for calculating the royalty take, the specific tax take includes the operational costs in its formula. This makes this mechanism somewhat more complicated than the royalty calculation, which requires only the volume of production. The role of costs in the calculation may be a cause of tension between the operating company and the state owner, since inflated costs directly affect the government take.

3. Royalty Payment and Specific Oil Taxes

In most oil-producing countries, governments combine both royalties and specific taxes as oil rent–capturing mechanisms. From the government perspective, the royalty secures minimum revenue even when the rent drops, particularly in the case of a sudden price collapse, and the government take increases with the rent when the rent goes up by means of the specific oil tax.

From the company's perspective this is not the ideal scenario, as it will have to absorb the burden of the rent drop because the royalty is not proportional to margins, and high taxes will take a sizeable share of rent increases when they occur. However, the impact of the combination of both devices in real life depends on their magnitudes and how they are combined.

4. Down Payment

The resource owner may decide to leave the fixing of the government take to market forces through competition among potential operators. Using basic geological data, the interested companies may assess what their minimum desired profit per barrel would be and then offer the rest of the operational surplus as a discounted rent payment to the government.

There are two basic shortcomings to this rent-capturing device. The first is the possibility of collusion among companies in the bidding process, and the second is that the government is left defenseless in the event of a sudden increase in the rent level for reasons that are not operational. These are reasons why this rent-capturing mechanism is regularly used in combination with other devices such as royalties and/or specific tax payments.

When used in combination with these other rent-capturing mechanisms, the down payment may help to compensate for the shortcomings of fixed rates, because if a potential investor perceives a potential upside in the investment, it will bid to ensure it enters the field being optioned. Therefore, upfront cash payment would be added to the ex-post royalty and tax payments, bringing total rent collection nearer to its market value.

B3. Government take, Investment and Production

We have mentioned the potential tradeoff between government take, investment and production. In fact, too large a take may force the shutdown of an active field with economic potential yet to be developed or hamper altogether the development of a marginal field under the prevailing rent-capturing parameters. Furthermore, like any other mining activity, oil production requires a minimum level of permanent investment to keep production going.

A minimum investment is required to compensate for the natural exhaustion and loss of productivity of the reservoirs as they are depleted. Investment below the minimum will cause production to decline and therefore, so will revenue and government take. If the cause of falling investment is too much fiscal pressure, then falling production may lead to a vicious circle whereby falling revenue leads to higher government pressure, which leads to even lower investment, thus accelerating a decline in production.

The logical consequence of this argument is that a targeted government take that is too high will prevent economic activity altogether and thus keep the government from generating revenue from oil production and productive activity in oil-related industries and services. The complex relationship between the government and the oil industry is discussed at length in the next section, where we analyze the stylized operational institutions governing the oil sector.

C. Operational Institutions And Industrial Organization

State ownership and how the state decides to develop its oil-bearing lands and organize production determine the structure of institutions and industrial organization of the oil sector.

To organize our analysis of the main features characterizing the organization of the industry and the institutions governing the performance of the oil sector, we have described the taxonomy of different international models, with regard to how the state as owner of the natural resource organizes the development of oil reserves in its territory.

Using this taxonomy we have identified two families with similar features. In the first type of family, the state develops the reserves directly through monopoly ownership of a company that retains monopoly control of oil production in the territory. There is no direct independent private investment in oil production. In the second type of family, there is direct private investment in oil production, either in state-owned lands under state regulation or under free access, or in privately owned lands. This last

case exists exclusively in the United States, where underground reserves belong to the private owner of the land.

Each one of these two families can in turn be divided into subfamilies depending on the degree of government intervention in oil production. The first family, in which the state retains monopoly control of production, is split into one subfamily where the government intervenes directly in the operations and financial management of the company. In the second subfamily, the relationship between the government and the state-owned company is at arm's length, with the state as sole shareholder of the oil company run as a private firm.

For the second family, wherein the state relinquishes direct monopoly control of production on state-owned lands, the first subfamily is one in which the state retains indirect control through a non-operating regulatory agency that administers the oil-bearing lands on behalf of the owner state. In the second subfamily the state gives private operators free access to potential oil-bearing lands without any restrictions other than that they must follow the same laws and regulations as any other industrial company. In the third subfamily, in which private companies operate in privately owned oil-bearing lands, these companies may be asked to pay special oil taxes in addition to the royalty paid to the private owners of the land.

Although the features of the oil production sector in most countries around the world fall into the above set of families, there are countries with features that fit into more than one. Therefore, rather than isolated categories, what we observe in real world examples is a continuum of institutional arrangements governing the oil sector, ranging from strict government control of the oil industry to freely operating companies with no governmental restrictions other than general laws.

Before we discuss the political economy of oil production within the framework described above, we need to discuss salient features of the contracting process for oil investment and production.

C1. Contracting for Oil Investment and Production

Whether the state develops the reserves directly, through monopoly ownership of a company with monopoly control of production, or indirectly, through a government institution such as a non-operating regulatory agency that administers the development of the reserves on behalf of the owner state, there can be different forms of private participation in oil investment.

When the state maintains direct monopoly control of production, private companies can participate in at least two ways: as service providers, producing oil for the state-owned company for a contractually fixed fee, or as equity partners, through joint ventures in companies that remain under state control.

In the case of indirect state control of production, private companies can invest directly in the development of reserves under concessionary contracts with the state. Typically the state will open up oil-bearing lands to the highest bidder under different bidding parameters. The bidding companies can be privately or state-owned, local or foreign.

In any event, investment in oil production has several idiosyncratic features that make contracting particularly complex, most of which are similar to those of other mining activities.

The following are the most salient features of investment in the oil sector:

1. It is made up front, and once committed it is difficult to minimize or delay;
2. It is asset specific, and once deployed has no alternative uses;
3. It is large (by any standard);
4. The recovery periods are long;
5. There are inherent geological risks;
6. As in any other extractive industry, due to the natural exhaustion of the reservoirs, there is a minimum investment level required to maintain a given production flow, and investment below the minimum will cause production to decline, with lower cash flow possibly leading to lower savings and thus lower investment, sparking off a downward spiral in investment;
7. The contractual relationship between a sovereign state owner of the reserves and an operating company, public or private, domestic or foreign, is asymmetric;
8. As in the case of many other commodities, prices are subject to wild fluctuations that lead to significant leaps in the magnitude of the economic rent to be shared between the resource owner and the operator, and an eventual profit squeeze as a consequence of falling prices and a rigid government take may put the profitability of projects in jeopardy;

9. The presence of economic rents in crude oil production and their distribution between the state owner of the resource and the operating company make for an inherently tense relationship between these two parties. The possible public perception or actual fact of unfair distribution of revenue between the state owner and the operating company in favor of the latter can create the conditions for a political wave of resource nationalism and the expropriation of companies' revenue over and above what is contractually established. This process can eventually lead to the expropriation of the private operator's assets in order for the state to assume direct control of production.

These features make investment in oil production a complex process. From a purely technical standpoint it is extremely specialized, requiring highly trained human resources, access to peak technology, and significant engineering capacity. From a financial perspective, it requires access to large savings and financing, usually syndicated financing, lasting more than a single year. It is subject to geological risks and price risks and, more importantly, it is prone to political risks that can lead to sudden changes in a preset institutional framework. Whether a company is privately or state-owned, investors are bound to face a very complex set of factors when evaluating and eventually undertaking an investment to explore or develop known oil reserves.

Private companies contracting with a sovereign state for crude oil production face a complex negotiating process. Companies require contracts with a minimum set of features: long-lasting concessions to realize the full potential of large investments; fair, credible and stable distributional rules; protection against sharp price fluctuations; safeguards and protection against the possibility of expropriation; and above all, credible national institutions trusted to be neutral in case of severe disputes with the sovereign state.

With the previous considerations as a background, we discuss the theoretical determinants of performance in crude oil production under the two institutional frameworks under consideration: direct state monopoly control of production and private investment in either state or privately owned oil lands.

C2. State Oil Company (SOC) Monopoly and Performance

Performance of the sector under direct state monopoly control of production through the monopoly ownership of the sole oil company operating in a country will vary depending on the degree of independence of the state oil company, whether there is significant dis-

cretionary intervention by the government or the relationship between the government and the company is at arm's length under a set of transparent, credible and respected rules.

1. State Oil Company as part of Central Government

An extreme case of SOC monopoly control of production under government control is when the company is in fact part of the executive branch of the state and is treated the same as any other central government entity such as a ministry. The company budget is part of the government budget, the company operations are decided in the context of government priorities, and there is no differentiation in the selection process or the compensation policy between SOC employees and other government employees. The operational and financial results of the SOC are not made explicitly public and therefore are not accountable.

2. State Oil Company independent under private Law

At the other end of the spectrum of SOCs under government control is the case of an arm's length relationship between the government and the SOC. In this case the SOC is a limited liability company with the state as sole shareholder. The company falls under the country's code of commerce and is a state-owned company under private law. The relationship between the parties is formalized through the shareholders meeting, where the annual budget and the company's results are approved. SOC performance indicators are made public and are subject to scrutiny, and the company is as liable as any other LLC. The SOC's management is professional, and it is run as a private company reporting periodically to a representative of the state owner in the shareholders meeting.

The real world morphology of the SOC under state monopoly will lie between these two extreme cases, and its location on that spectrum will determine its behavior and performance. For the analysis of concrete examples, it is necessary to describe the consequences of varying degrees of independence of the company in at least three key aspects of the oil industry: (*i*) oil revenue distribution; (*ii*) management of the oil company; and (*iii*) commercial behavior, competition, and accountability.

(*i*) *Oil Revenue Distribution:*

The more discretionary the government intervention on the distribution of oil revenues is, the less likely it is the company will make the necessary savings to finance required investment. When there is no discretion, and the government obeys preset distribution rules, the SOC is able to engage in appropriate financial planning for current and multiple-period investments.

When run as a state-owned company under private law, the company can use its cash flow to finance investments. Furthermore, if the markets trust the distributional rules cannot be unilaterally altered by government, the SOC can use the markets to finance productive investment as any other private company would do.

If distributional rules are broken and there is growing uncertainty with regard to available revenue, it would become more difficult for the SOC to plan future investments, and this would hamper possibilities for the multiyear investments intrinsic to large oil sector projects. The government may expropriate potential investments by the SOC by unilaterally increasing the government take over and above existing distributional parameters. There are multiple ways in which government can discretionally affect SOC revenue over and above pre-established distributional rules or distort the SOC expenditure. Among others these include:

- *Oil Fiscal Revenue:*

The formal oil fiscal revenue will be established in national law. In the case of state monopoly control of production, the extent to which the oil revenue is eventually appropriated by government will depend on the degree of government discretional intrusion in the finances of the company. In the case of an arm's length relationship where the SOC is run as a private LLC under private law, the government may as a first way of intruding into the operational surplus after taxes and royalties, claim as the sole shareholder a share of the dividends of the SOC to finance government expenditure.

As a consequence the SOC will not be able to count on the totality of its cash flow to finance investment and will have to either cut capital expenditures or take on commercial debt to finance investments. Assuming a case in which the SOC pays only the royalty and/or special taxes outlined in national laws, the effect of these special levies on oil investment will be those discussed at length in the above section on fiscal institutions.

- *SOC expenditure in non-oil activities:*

The government may as sole owner of the SOC force the company to finance and manage non-oil related activities. The capital and manpower allocated by the SOC to these activities will be at the expense of the core oil-related activities affecting SOC performance.

- *Subsidies:*

A mechanism with which the government can expropriate revenue from the SOC without altering the formal distributional rules is to force the company to subsidize sales to either the domestic or international markets at prices below international standards or even below production costs. Depending on the size of these markets and the magnitude of the subsidy per unit of fuel, the company's aggregate revenue loss may be considerable, and come at the expense of SOC savings and investment.

- *Oil Company Debt:*

Aside from expropriating current revenue by discretionally increasing its take, the government may force the SOC to increase its commercial debt to increase short-run transfers to the government at the expense of future company savings, therefore effectively also expropriating the company's future revenue.

(*ii*) *Management of the Company:*

A second condition affecting the performance of the SOC is the criteria for managing the company. The more government intervention in the management of the company, the less likely it will be to behave as one professional oil-company. The company will increasingly be used as an operational arm of the government to fulfill non-oil related tasks, diverting the attention of the company away from its core business activities.

The greater the degree of intervention, the more likely it is that the management and professional personnel will be chosen on the basis of political allegiances rather than on merit and technical skills. The oil industry requires highly specialized personnel with the capacity to accumulate knowledge about the different geological characteristics of the oil provinces in which the companies operate, and production technologies specific to those areas. This requires a human resources policy oriented toward building up a labor force with a long-run view, and the SOC must be prepared to compete with other companies for the best talent.

This may not be the case when the company is under close government scrutiny and permanent interference, since the government may prevent the company from paying internationally competitive wages, instead dictating wages that are comparable to those of other government employees. The government is also not likely to allow the first class technical training that is required. The lack of first class technical personnel and distractions that pull the company from its core duties partially explain the poor performance of state-owned companies under a high degree of government intervention.

(*iii*) *Commercial Behavior, Competition, and Accountability:*

- *Commercial Behavior:*

The greater the government intervention in an SOC, the less likely it is that the company will behave as a commercial oil firm. Aside from the possibility of being forced to undertake non-oil related activities, such as building up domestic infrastructure, assuming management or financing of social programs (among many other potential non-core activities), the SOC may also be forced to sell oil to international customers at below market prices for non-commercial reasons, and it may be forced to sell to the domestic market at heavily subsidized prices.

Undertaking non-core non-commercial tasks may affect the performance of the SOC, with consequences in at least two key areas: budget and manpower. The budget is affected from the revenue side, as volumes are sold below opportunity prices, and from the expenditure side, as financial resources are allocated to non-oil endeavors. Lower revenues and growing expenditures for non-commercial aims affect investment in core areas and thus the SOC's performance. The same can be said with regard to manpower—as the SOC is forced into non-core activities, the management and the labor force are distracted from areas of central business at the expense of the company's performance.

- *Competition:*

Productivity in the oil industry depends largely on natural conditions such as the productivity of reservoirs and the quality of the crude oil. High productivity wells of high quality oil will produce much higher yields than lower productivity reservoirs of poorer quality oil. Thus, to compare factor productivity among oil companies, it is necessary to discount the productivity of the natural resource at the reservoir level.

By definition an SOC with monopoly control will have no competition and therefore no formal benchmark under the same reservoir and crude quality conditions, which are unique to each geological province around the world. In the case that there are companies operating in the country as service providers or partners in joint ventures, the SOC will have an objective benchmark to use as a comparison.

However, the incentive to change will be minor, given the non-commercial character of the monopoly. It will be up to management to implement productivity improvements, and it will ultimately come down to the degree of freedom of the company or, in the last instance, to the willingness of the government to drive these improvements in productivity.

Finally, the more the SOC is forced to undertake non-core related domestic activities, the more factor productivity will be affected as material resources and personnel are diverted away from essential oil activities.

The closed-to-competition character of direct state monopoly control of production may hurt the SOC's access to international financing, technology and expertise.

The greater the government's discretion in deciding oil revenue distribution, the more difficult and thus more expensive it will be for the SOC to find international commercial financing for its operations and investments. It will be possible for some conditional nation-to-nation loans to develop the domestic oil industry, but these will always come with strings attached, such as terms of preferable commercial conditions or a share in output.

The same happens with access to expertise and state of the art technology—although in today's oil industry there are a large number of specialized service industries providing access to peak technology for a fee, it can be the case that these companies require participation in operations. Very commonly, however, the SOC will lack properly trained personnel to incorporate and operate these new technologies.

The monopoly nature of the SOC implies a monopsony power to purchase goods and services for the oil industry. This can be a useful way of using the SOC's large expenditures to promote domestic goods and services in its procurement. However, the monopsony power of the SOC can have unintended consequences in more than one respect. The SOC may use its sizeable unregulated power against national producers in a clearly asymmetric relationship.

On the other hand, if forced to purchase domestic goods or services, this can be at the expense of the company's productivity, since it could purchase such goods overseas at lower prices and/or higher quality. Striking the right balance without market or

regulatory constraints may lead to corruption and/or missed opportunities, among other negative consequences of an SOC monopsony in the oil sector.

- *Accountability:*

As with other issues previously discussed, transparency of data for accountability purposes will depend very much on the degree of independence of the SOC. If the SOC is run as a limited liability company, with the state as sole shareholder, and performs under the country's code of commerce, it must periodically make public the independently audited financial and operational results of the corporation. This would certainly be the case if the SOC secured financing in international capital markets, since as a condition of those loans the company would be required to disclose its audited annual results as the loan is executed.

However, if this were not the case, the SOC's transparency for accountability purposes would depend on the will of the government. The government can invoke its sovereignty to partially or totally withhold the SOC's financial and/or operational results. Lack of accountability may lead to poor operational and financial practices being left uncorrected, thus allowing for immoral practices within the SOC, leading to deteriorating performance.

Conclusion

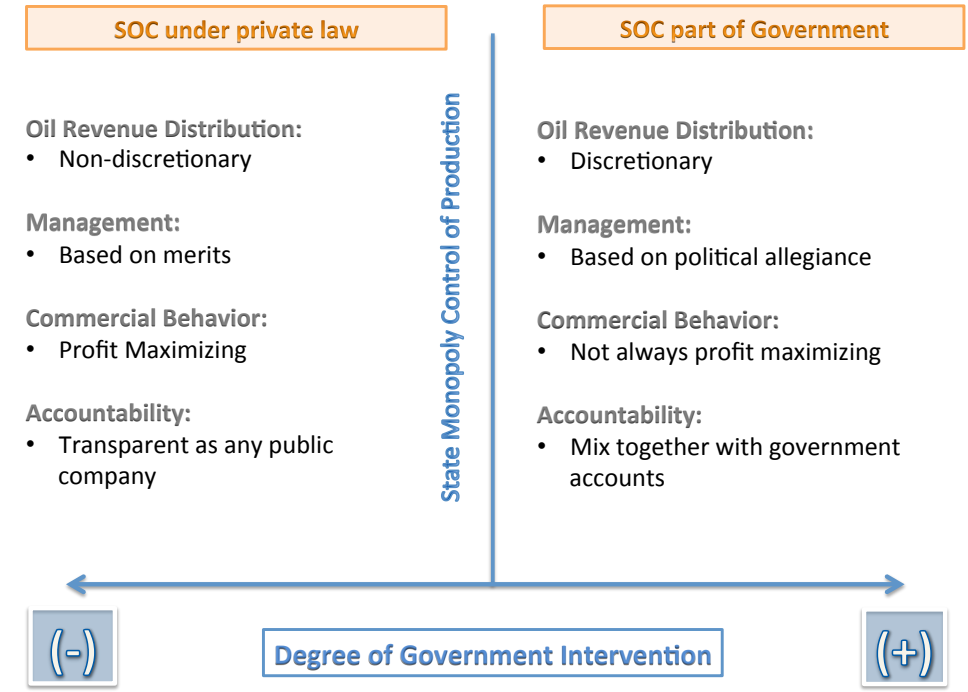
The family of countries with institutional arrangements in which the state exercises full control of reserves through the monopoly control of production can be divided into two subfamilies depending on the degree of government control of the state-owned monopoly.

We have measured the degree of government intervention on the basis of four parameters: revenue distribution, management selection, commercial behavior and transparency. At one extreme the oil company behaves as part of government, and this translates into discretionary revenue distribution, management that is appointed on the basis of political allegiances, non-commercial behavior and opacity in presenting results. At the other extreme the oil company fully owned by the state can be run under the code of commerce at arm´s length. Revenue distribution takes place under preset distributional rules, the management is appointed on the basis of merits, the behavior is commercial and presentation of results is fully transparent.

For the reasons argued above, one would expect a state oil company run at arm´s length to be show better performance than one under direct government control.

We can plot the two subfamilies in which the state retains monopoly control of production along an axis depending on the degree of government intervention as shown in Figure 1, from less government interaction on the left to more government intervention on the right, according to the different parameters analyzed.

Figure 1:



Source: Author's elaboration

C3. Private Direct Participation Competition and Performance

The state may wish to hand over concessionary contracts for the development of the country's oil-bearing lands to private companies, whether or not there is a state-owned company. Performance in this circumstance also depends on the degree of independence from government regulation and control the operating companies have.

As owner of the reserves, the state may want to control and regulate the development of the reserves or leave it free for the companies to operate. As sovereign fiscal authority, the government may wish to impose specific taxes on oil activities even if they take place on private lands.

As stated above, direct private investment in oil production in state-owned oil-

bearing lands takes place within two general institutional subfamilies. In the first, the state regulates production under a non-operating regulatory agency and, in the second, there is free private access to public oil-bearing lands without any specific state regulatory intervention. The case of private companies operating in private lands in the United States is very similar to the latter and will be described jointly.

1. Private Investment under Regulation and Control

The government, on behalf of the owner state, may want to regulate oil production for at least three basic reasons: (*i*) to ensure the best possible development of the reservoirs from a geological perspective, maximizing the recovery of oil and minimizing the ecological and social impact of oil exploration and production; (*ii*) to closely control the development of the reserves to ensure that the state gets the maximum economic rent derived from the sources described above, which may include not only certification of production levels but also close scrutiny of operational costs by operating companies; and (*iii*) to maximize the productive impact on the national economy in terms of demand for goods and services and the employment of the national labor force. The latter reason may also condition private investment in the transfer of technology and expertise to national companies by different means.

Regulatory Agency

In the case of the state opening oil-bearing lands under direct regulation, an institution is needed to perform such a role. This could lead to the creation of a special-purpose national institution such as a national petroleum agency (NPA) or the assumption of regulatory duties by a specific department within the ministry in charge of energy and/or mining.

There are a few conditions for creating a world-class special-purpose independent regulatory agency. First, the agency would require highly specialized personnel including geologists, reservoir and petroleum engineers, petroleum financial assessment specialists, and lawyers who specialize in contracting for oil production. The hiring of these personnel to essentially run the national counterpart of powerful private companies may require renumeration higher than the norm for central government employees.

Second, continuity of the staff administering the national petroleum reserves is of paramount importance to manage long-lasting contracts, and should not be subject to political change. Indeed, the board directing the agency should be selected in a staggered manner not coinciding with changes in government, and should be elected by

representatives of more than one branch of government, to lessen the risk of government intervention.

In this way the agency should be truly independent. The features of specialized staffing, continuity, and independence make an NPA similar in its conception to a central bank, which, like an NPA, is charged with administering a national stock: the monetary base and the international reserves.

The essential roles of an NPA are the following: (*i*) to assess, map and store geological data about the country's oil-bearing lands; (*ii*) to implement policies that open up prospective territories and evaluation scales for different parameters; (*iii*) to prepare bidding packages, carry out the bidding process, select a winner, draft and sign concessionary contracts; and (*iv*) to enforce contracts on behalf of the state owner of the reserves, including auditing production, production costs and fulfillment of social and environmental safeguards.

2. Free Private Investment

On the other extreme of direct private investment in oil production is the free ownership of reserves, in the case that the state relinquishes its property rights in favor of the discoverer of commercial reservoirs.

The government—on behalf of the owner state and through an indefinite contractual agreement—hands over the development of a given territory to a private company. The state rules whether the owner of the land is to be compensated and how.

In this case, the operating company is not subject to any regulation and pays specific oil taxes if necessary. Certainly the company is subject to the law of the land, as would be any other commercial firm. In the case that the oil-bearing lands are privately owned, the oil company interested in developing the underground reserves must reach a contractual agreement with the owner of the land to gain access to the reserves under concessionary conditions, paying a royalty or some other sort of rent to the private owner of the land and, if necessary, also paying specific oil taxes to the government.

The actual real world morphology of private participation in crude oil production lies between these two extreme points, free access and state regulation. Before analyzing the behavior and performance of countries with direct private investment and competition and with different degrees of government regulation and control, it is necessary to emphasize that these two arrangements do not prevent direct participation by fully or partially state-owned oil companies. As a matter of fact, this is a common arrangement and we shall pay particular attention to how operation under this type of arrangement

affects the state oil company.

To analyze performance and behavior of companies in competition with private and state direct investment we shall resort again to the three key aspects used to analyze behavior under state monopoly control of production: (*i*) distribution of the oil revenue; (*ii*) management of the oil companies; (*iii*) commercial behavior, competition, and accountability.

(*i*) *Oil Revenue Distribution:*

Oil revenue distribution in a system with competition is set by contractually-fixed fees and taxes and royalties that are established by law. The stability and credibility of these distributional parameters is of paramount importance for investments to materialize.

- *Oil Fiscal Revenue:*

Assuming the rules dictating fiscal distribution are trusted and perceived as stable, the performance implications of the different rent-capturing devices will be those analyzed and discussed in the section on fiscal institutions above.

- *Regulatory Agency and Revenue Distribution:*

Having a regulatory agency may work in favor of the companies that will have a technical interface with the government. The NPA may act as a buffer between the two parties in the case of disputes on how payments are calculated or if any party needs to amend the original contract. The NPA should have the technical knowledge, prestige and position to intermediate between the parties.

The NPA would contribute to the stability of the usually tense relationship between the government representing the state owner of the reserves and the operating companies developing such reserves under concessionary contracts. The agency would give flexibility to an inherently inflexible relationship that is characterized by mutual distrust and prejudice.

- *The SOC:*

If preset distributional rules are followed, the main beneficiary would be state-owned companies. SOCs would be covered under the same umbrella as private companies, and discretionary distributional action by the government against its own company would be regarded as unfair. Government expropriation of SOC revenue would reduce the

SOC's savings for financing investments and would place it at a disadvantage vis-à-vis private companies in the same country.

The commercial character of the SOC in competition with private companies should limit potential government discretionary action that may disadvantage the national company. The government would put its company at a disadvantage if it were to force it to go into commercial debt to transfer resources to finance government expenditures.

- *Subsidies:*

Assuming fuel subsidies are not established in the concessionary contracts, the operating companies would not be forced to finance them in the domestic market. If such subsidies exist, they would be assumed by the government and accounted for in the national budget. Forcing an SOC to assume any subsidy to the domestic market would put the company at a competitive disadvantage in relation to privately owned and operated companies.

3. Privately Owned Oil-Bearing Lands:

In the case of private companies operating on privately owned lands, the operational surplus would be distributed between the operator and the landowner on the basis of contractually agreed-upon royalties or fees. On top of royalty payments, the operating companies would have to pay regular taxes and any additional taxes established in the national tax laws levied to extractive industries in general, particularly taxes in the case of windfall profits.

(*ii*) *Management of the Companies and the NPA:*

The companies would be staffed and managed according to best practices to achieve maximum productivity in a competitive environment. Given the natural characteristics of the reserves to be developed, including geology, pressure and the quality of the hydrocarbons, the companies would compete for the best professional personnel to maximize production given the institutional constraints set in the contract and supervised by the NPA. Likewise the companies would look for the best commercial experts to extract the highest market value for their products.

For countries with an institutional arrangement including a regulatory agency, the state competes with oil companies to staff the government oil institution. Staffing the NPA with the best-qualified professionals is essential to securing the maximum revenue

for the nation from the exploitation of its natural resource and the best recovery of the reserves in an inter-temporal framework. Staffing the NPA would put additional pressure on the labor market for specialized oil professionals.

(*iii*) *Commercial Behavior, Competition and Accountability:*

Within this family, oil companies must compete to maximize revenue. This, in particular, conditions the behavior of the SOC. If forced to subsidize sales or assume non–oil related activities, the SOC would lose its competitive edge, to the detriment of the state. Government revenue would be affected in two ways: lower revenue for the SOC and, due to lower productivity, lower revenue for the oil sector as a whole.

Competition for financial and other resources in open competition forces the companies—including the SOC—to disclose their financial and operational statements to show their capacity to fulfill market expectations and honor their debts.

The more investors trust the stability and fairness of the institutions and distributional rules, the faster they will react to changes in price signals. Due to competition among investors, this institutional setup would produce better performance than the institutional family with state monopoly control of production.

C4. Conclusion

The family of countries with institutional arrangements that allow for private direct access to reserves and control of production under competition can be divided into two subfamilies, depending on whether companies have free access to reserves that are privately or state-owned, or whether access to and development of the reserves is regulated by the state.

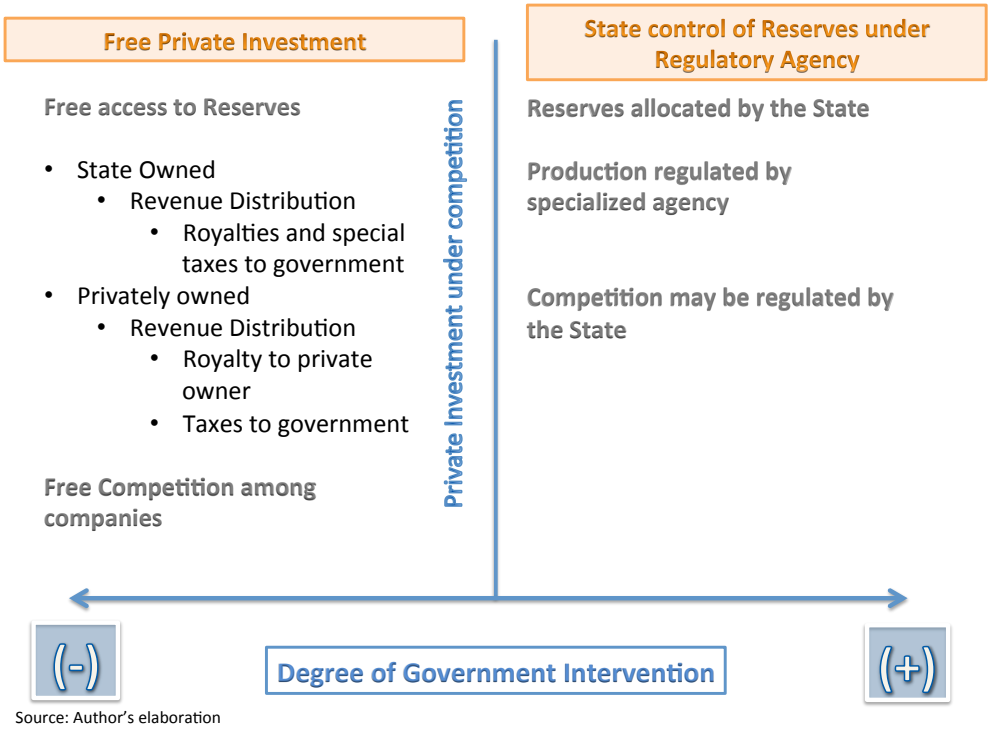
In the case of free access, companies pay a royalty to the private owner of the land or to the government in cases where the reserves are state-owned. Other than that, the companies are subject to the same taxes and laws as any other commercial firm. In the case of private production under state regulation, the state regulation can range from regulating access to the reserves to regulating production for geological, environmental, social or other reasons.

For the reasons argued above, one would expect companies with free access to reserves to perform better than those operating under state regulation.

In the same way that we plotted the families of countries with monopoly state control of production based on the degree of government intervention in the industry, we can

plot the families of companies with private direct access and control of production along an axis depending on the degree of government intervention in the running of the oil industry in Figure 2, going from minimal state intervention (beyond that applicable to any commercial firm) on the left to greater state intervention (regulating access to reserves and operation) on the right.

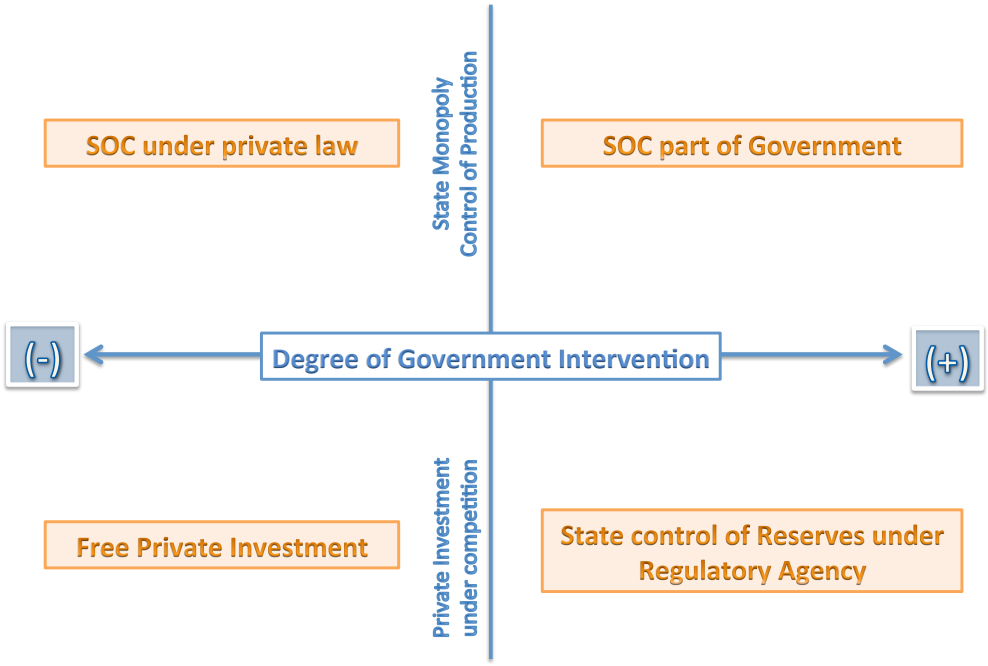
Figure 2



Source: Author's elaboration

Finally, we can combine the set of families described above in a single Cartesian system as shown in Figure 3. In the upper half, we plot the family of countries where the state controls the development of reserves through monopoly ownership of a company that has monopoly control of production. As we did in Figure 1, we can draw these countries from left to right, from lesser to greater government intervention. Likewise, in the lower half, we can plot countries in which private companies have direct access to reserves and control production. As in Figure 2, we can plot the countries from left to right depending on the degree of government regulation of the activity from free access to regulated access.

Figure 3



Source: Author's elaboration

Plotting the countries according to the institutional frameworks of their oil industries in this system, we could rank their performance in response to a permanent change in the price signal. Countries in the south west quadrant should respond faster than the rest, followed by countries in the south east quadrant, then the northwest quadrant, and finally the northeast quadrant.

Performance measured as the speed of response to change in price signals perceived to be permanent may vary according to the way each country's oil industry is set up, from free competition with free access to reserves and private control of production, to private capital access to reserves under government regulation, to state monopoly control of production at arm´s length, to state monopoly control of production under direct government control.

Within this analytical framework we shall next analyze the evolution of the institutional framework and the performance of the oil sector of the seven largest crude oil producers in Latin America over the last fifteen years.

2 Empirical Evidence

It is our contention that the diverse reactions to the price signal among the largest Latin-American oil producers can be explained by differences in the institutions governing the oil sector in each country. As a matter of fact, each of the two sets of countries we grouped together according to their similar institutional frameworks and the way the oil sector is organized in each had fairly uniform responses to the price signal within the group. In this section, we explore the common institutional features of the two groups and their similar market behavior.

Market Signal: Upward break in Price trend

Over the last eighteen years, oil prices increased almost fourfold in real terms, from about 26 per barrel ($/b) in 1995 to 94 ($/b) by the end 2013.[5]

Following a similar approach as in Espinasa et. al (2012), we start by identifying whether there has been a change in the real value of prices over time or if prices have remained stable over this period. That is, we estimate the time break in price trend.

To test the null hypothesis that oil prices have been stable in real terms during the period we use the following equation[6],

$$p_t = \beta_0 + \beta_1 * t + \epsilon_t$$

The evidence against that hypothesis can be found by identifying significant changes in the time trend coefficient. The inflection point for the break in the price trend comes from minimizing the sum of square errors (SSE) using the following regression,

$$p_t = \beta_0 + \beta_1 * t + \beta_2 * t * break + \varepsilon_t$$

Figure 4 shows the WTI marker crude monthly prices in real terms between January 1995 and January 2014. Figure 5 shows the same prices expressed in logs and the trend using the Hodrick-Prescott filter. It shows the quantum leap in prices and the inflection in the trend slope.

[5]Growth in developing countries, especially China and India; the inability to increase oil supply to meet demand and speculation in financial markets were commonly used to explain the steep rise in global oil prices during the period of the analysis.

[6]Oil prices were expressed in logs, seasonally adjusted and then filtered using the well-known Hodrick-Prescott procedure to filter short term market fluctuations from long-term trends.

Figure 4

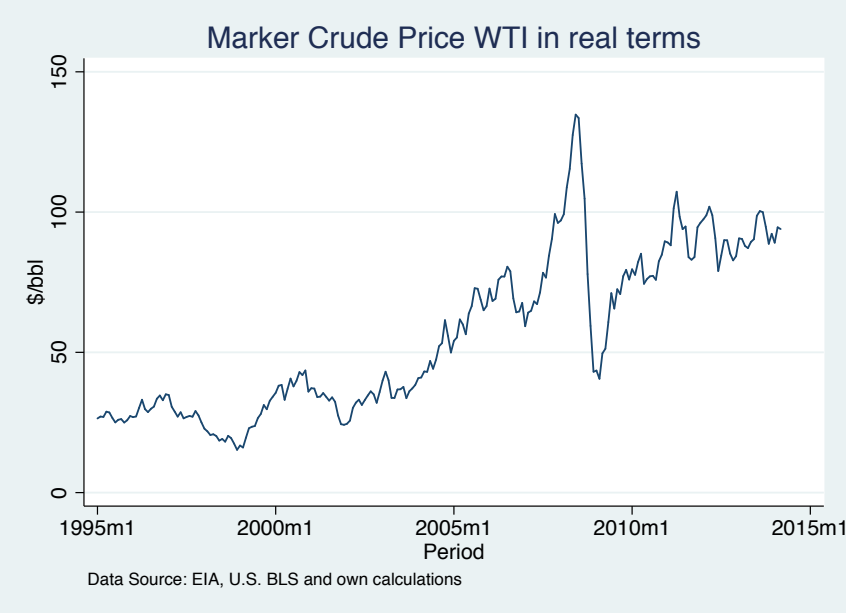
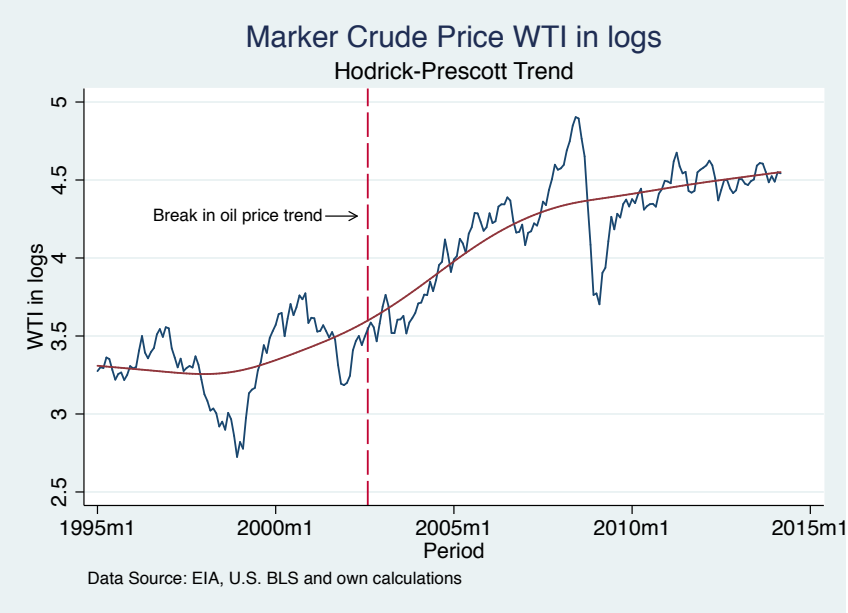


Figure 5



Performance: Investment and Output

In a world with free access to oil-bearing lands and free capital mobility, it is expected that investment would increase in response to a quantum leap in prices, leading to higher crude oil production. However, based on evidence from the last nineteen years,

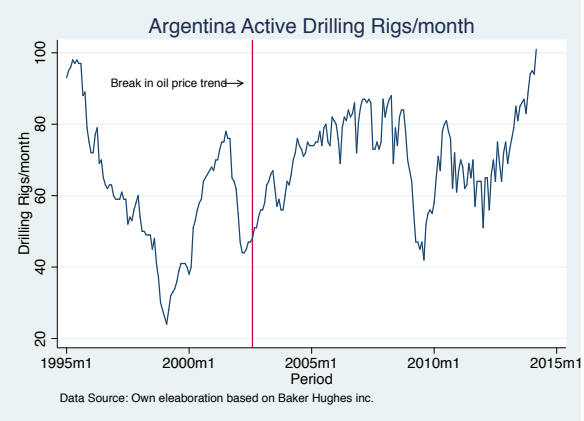
this has not uniformly been the case among the seven largest oil-producing countries in the Latin American region. It is possible to group these countries together according to their response to this unequivocal and sustained price signal.

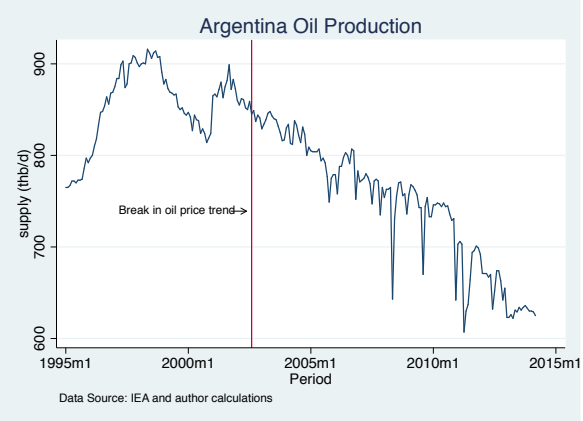
Group I

The first group of four countries, Mexico, Venezuela, Argentina and Ecuador, did not respond to the positive price signal, and investment as measured by drilling activity remained essentially constant, at levels too low to compensate for the natural productivity loss of the reservoirs, leading to declining production in each.

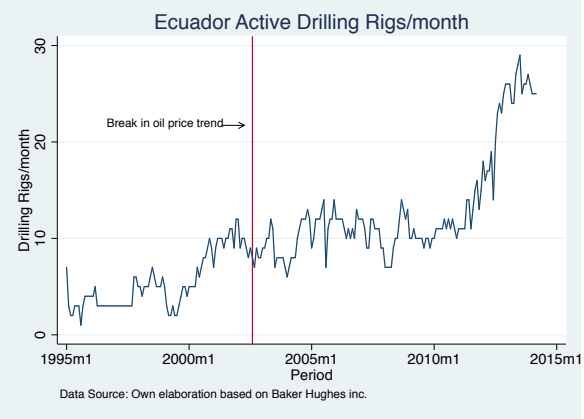
Figures 6 $A-B$, 7 $A-B$, 8 $A-B$ and 9 $A-B$ show drilling activity as the best proxy for investment, and monthly crude oil output for these four countries for the period under analysis. The price trend break date is superimposed on top of the drilling and output graphs.

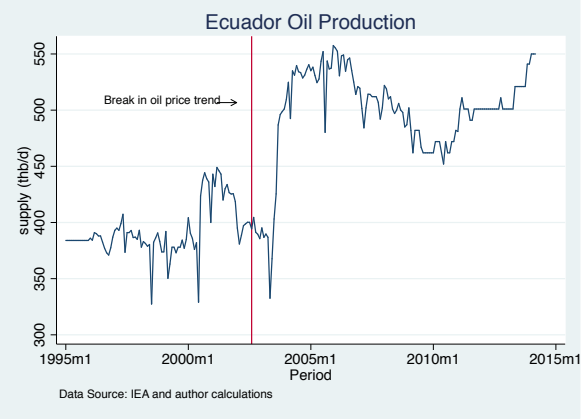
Figures 6 A-B



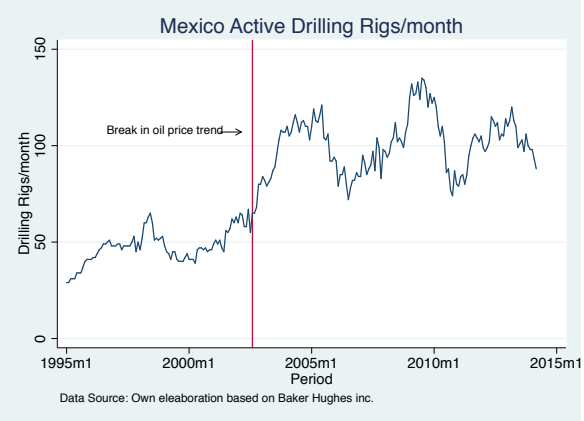


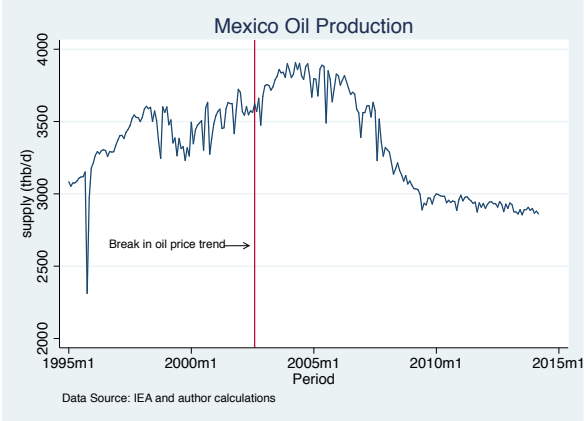
Figures 7 A-B



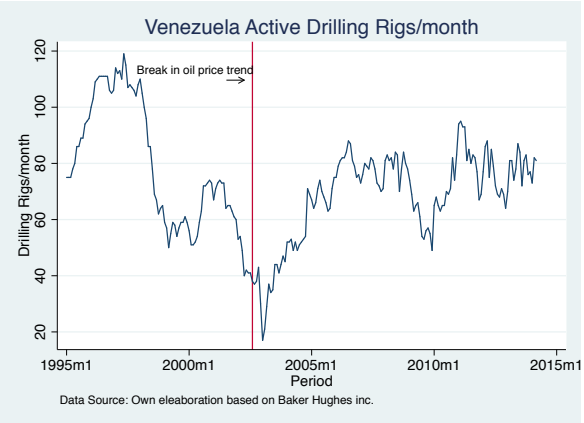


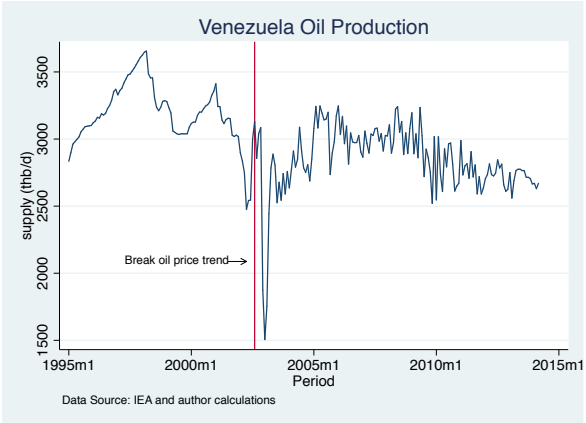
Figures 8 A-B





Figures 9 A-B

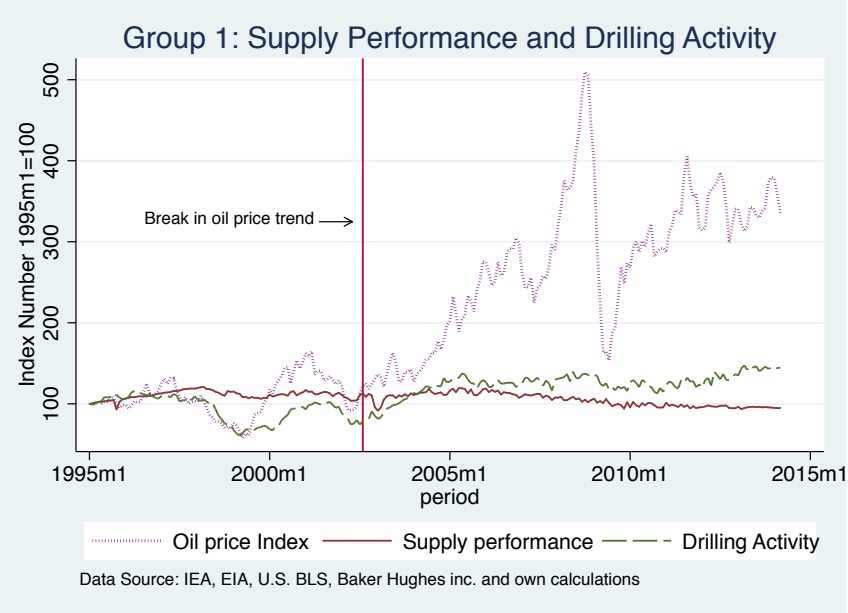




It can be seen that in each individual country and for the group as a whole, there is no major drilling reaction to the price break. Given the magnitude and the duration of the transition to the new price regime, there is no sustained homogeneous investment increase in response to the quantum leap in prices. In fact, drilling activity for the group as a whole as well as for each individual country is not enough to compensate for the arrest in oil flow due to declining reservoir pressure, and output drops considerably in all four countries. Lack of investment explains the paradoxical reaction of this group of countries, with sharply declining production vis-à-vis a sharp upward movement in the price regime.

Figure 10 shows the index numbers for prices, drilling and output for the countries in Group I. During the period of the fourfold increase in price, drilling activity remained roughly constant, and for the group as whole production fell roughly 13% or 1Mbd (from 7.7 down to 6.7 Mbd) between late 2002 and early 2014.

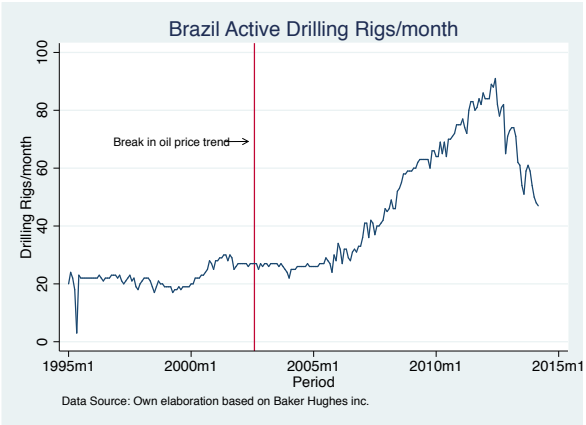
Figure 10

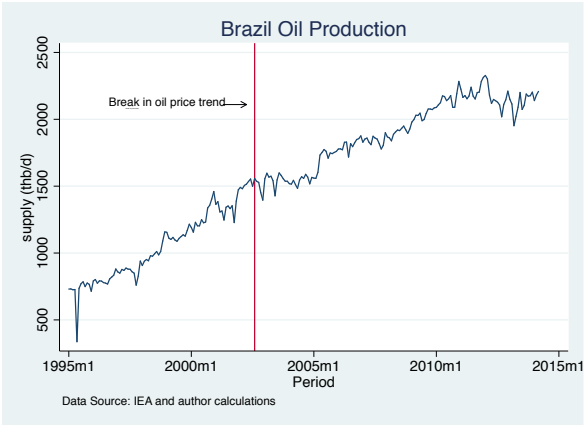


Group II

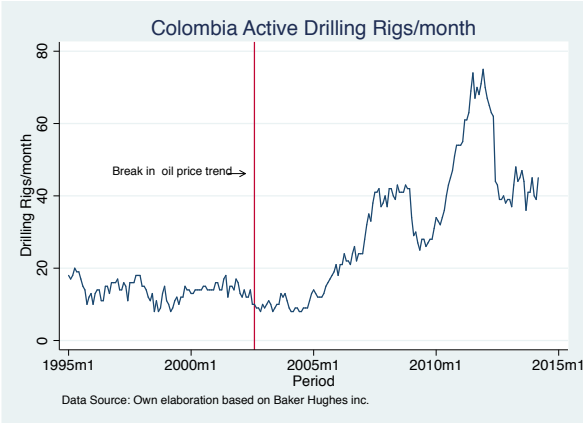
A second group of three countries, Brazil, Colombia and Peru, responded to the positive price signals by sharply increasing investment, as seen in a quantum leap in drilling activity and a subsequent increase in output. Figures 11 A-B, 12 A-B and 13 A-B show drilling activity and oil output for these three countries. There is a clear response of sharply increased drilling activity followed by booming output.

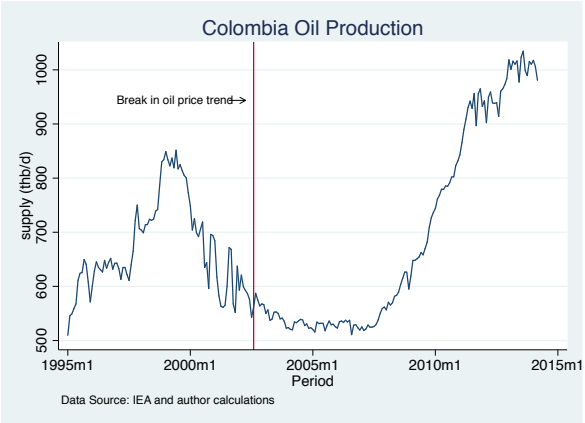
Figures 11 A-B



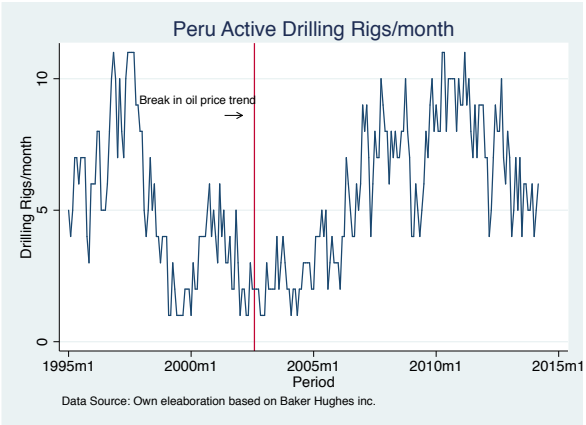


Figures 12 A-B





Figures 13 A-B



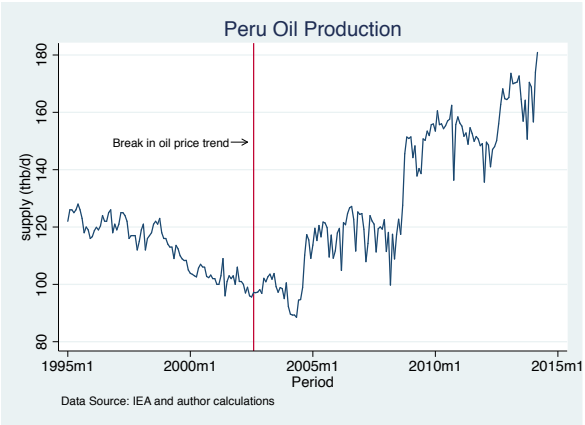
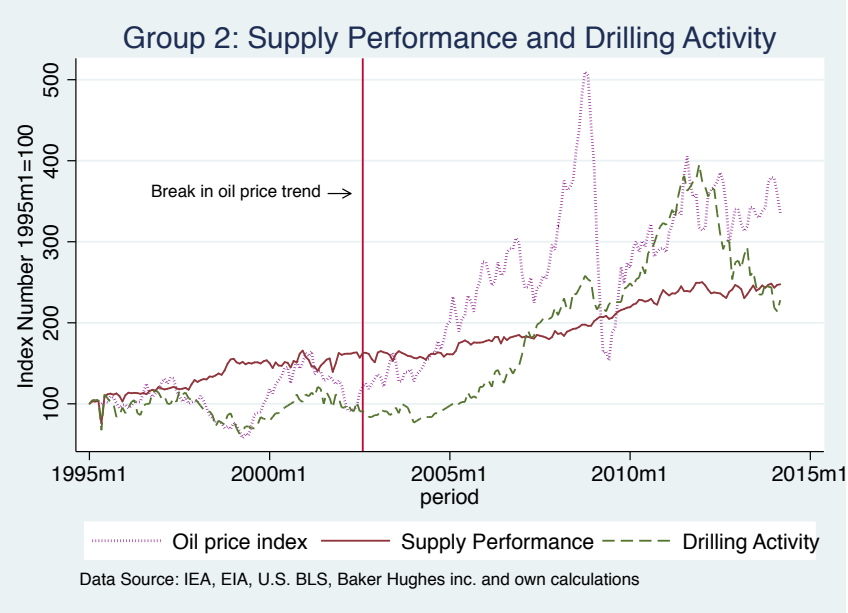


Figure 14 shows the index numbers for prices, drilling and output for Group II countries. The three countries all increased crude oil production. Collective production increased by 51% or 1.1Mbd (from 2.2 up to 3.3 Mbd).

Figures 14



Institutional framework and Performance

We will describe the evolution and present morphology of the institutional framework for the countries in each group and place them within the taxonomy we developed in the analytical framework. We will also identify breaking points in the evolution of the institutional framework for the countries under analysis and discuss how these institutional changes may have altered the investment environment and thus conditioned the response.

Group I

The first distinctive feature of the institutional framework governing the oil sector in Group I countries is that the government exercises a high degree of discretionary interference in the running of the oil industry in the period under analysis. In three of the four countries in this group, the state exercises its property rights on the natural resource through monopoly ownership of the oil company, with a monopoly on oil production. This is the case in Mexico, Venezuela and Ecuador. In the case of Argentina, the state recently took control of the largest oil company in the country, and for several years prior, the government had directly intervened in the oil sector through various executive orders.

The oil sectors of the countries in Group I can be classified into the first of the two types of families described in the taxonomy. As we pointed out when describing the taxonomy, there is not always a clear-cut relationship between the features of a specific country's oil sector and those described for each category in the more abstract classification. There are shades to the characterization, however the countries in this group share the most important feature, which is state control of production through the monopoly ownership of a company that has monopoly control of production in each country. What varies is the degree of government control in the running of each company.

In the analytical framework we identified two subfamilies depending on the degree of government interference in state-owned companies, those that are run at arm's length on one extreme and those that are part of the central government on the other. For the reasons given in the analytical framework, it should be expected that the first subfamily would perform better than the second.

Argentina: In the late 1990s Argentina underwent a profound process of privatization and liberalization of public utilities.[7] This led, among other things, to the privatization of the state-owned company YPF.[8] The influx of capital, technology and engineering, together with the adoption of international prices, led to the expansion of hydrocarbon activity in Argentina at the turn of the century. The expansion of the sector was brought to a sudden end by the reversal of liberal economic policies coinciding with the swearing in of President Nestor Kichner in May 2003, ushering in a period of growing government intervention in the oil industry. A number of executive orders were enacted that severely affected the economics of the hydrocarbon industry in the country and brought investment to a halt. Among these measures, three key ones were the regulation of domestic fuel prices at prices well below international levels; the imposition of hydrocarbon export quotas, and the imposition of a specific oil export tax.[9] The growing government interference brought about an ever more tense relationship between private operators and government. The growing tension ended with the forceful expropriation of the largest operator, YPF-Repsol, in 2012 and government

[7]The privatization of a number of public utilities and state-owned companies was part of a series of reforms undertaken under the administration of President Carlos Menem, oriented toward reducing the size of the state and putting public financial accounts in order. The reforms were undertaken between 1989 and 1992.

[8]The privatization process began in 1992 and culminated in 1999 with Repsol owning a 51% stake in YPF-Repsol with an estimated payment of around $15 billion.

[9]In March 2002, crude oil exports were limited to 36% of production in the national territory. Gas exports were also limited and eventually terminated between 2002 and 2008.

takeover of oil sector operations.[10]

Ecuador: Over the decade from the mid 1990s to the mid 2000s, Ecuador carried out an oil policy oriented toward opening spaces to private capital in two ways. First it allowed private operating companies to invest in the development of marginal fields in association with the state-owned company PETROECUADOR. Second, the construction of a second pipeline, the OCP, created to transport heavy crude oil from the jungle fields in the east of the country across the Andes to west coast terminals, was financed by private investment. This led to a quantum leap in oil production, since transportation infrastructure is the main bottleneck for increasing production in Ecuador. The opening did not mean that PETROECUADOR surrendered monopoly control of production or the direct operation of the most prolific fields. Private capital, engineering and technology increased production in marginal fields and expanded transportation capacity, explaining the sharp increase in output in the first half of the decade. The expansion in activity and production came to an end with the change in oil policy orientation following the swearing in of Rafael Correa as president in January 2007. The reversal in oil policy orientation put a halt to growing private capital investment. There were three key measures: first, an extraordinary profits tax was imposed that went beyond what had been contractually agreed upon, limiting the profits of private operators in the face of increasing oil prices;[11] second, drilling in the marginal fields was limited to horizons above 10,000 feet, putting pressure on the private operating companies; and third, companies were forced to change their status from partners of PETROECUADOR, sharing profits in the development of marginal fields, to mere operators for an operational fee.[12] [13] Since 2012, the government of Ecuador has allowed

[10]The expropriation took several stages. First was the forced sale of a 25% stake in YPF-Repsol to the local Group Petersen between 2007 and 2011, to be paid for out of future profits. Second, in April 2012, citing reasons of national interest, the government expropriated 51% of the capital of YPF-Repsol from a total 57% share owned by Repsol.

[11]On October 4th, 2007, President Correa announced the enactment of an extraordinary surplus tax on private companies' export revenue, aimed at capturing 99% of profits when prices exceeded $70/b.

[12]In 2008 the Government of Ecuador began negotiations with private firms to change and in effect downgrade their status from partners to operators of PETROECUADOR. Under the new status, the companies would be paid a fee per barrel of oil produced, which was not linked to the price of oil. As partners, the companies would get a share of production as under a production-sharing agreement. As a coercive measure the executive branch sent a law to Congress for approval to expropriate the assets of private oil companies that refused to sign the new service contract. Mounting pressure led to a sudden drop in foreign investment in Ecuador's oil sector.

[13]Increased government pressure led to the drafting and signing of new operational contracts with foreign companies such as Repsol-YPF, Petrobras and Andes Petroleum, owned by China National Petroleum Corporation.

an increasing flow of foreign investment into specific projects and created a second state oil company to develop newly prolific areas.[14] This has translated into increasing activity and production in recent years that took place without a major overhaul in the institutional framework.

Growing pressure on the private sector explains the drop in investment as measured by drilling activity and explains the drop in production after 2007. The institutional framework evolved in the period under analysis, from openness to private investment that brought about much needed additional infrastructure (OCP) to a closing of those opportunities as government control grew. In terms of our schematic framework, Ecuador moved from the northwest to the northeast quadrant.

Mexico: PEMEX is a fully state-owned company with full monopoly control of oil production in Mexico. During the period under analysis, it was run by professional management with a fair degree of operational independence from government. However, the government put sustained fiscal pressure on the company, imposing a degree of discretion on the distribution of the operational surplus. According to PEMEX financial results[15], for the decade ending in 2008, the company showed a consistent net income loss since the government take exceeded the company operational surplus (operational revenue minus operational costs). Operational costs were on average 43% of the operational revenue, and government take was around 63%, which explains the net income loss as an average of 6% of the operational revenue. Thus PEMEX was forced to go into debt to partially finance investment. It must be reiterated that PEMEX was forced to go into debt to transfer resources to the government over and above all available operational surpluses, regardless of the oil price level.

Until 2007, PEMEX was able to invest well above available industry cash flow with off balance debt under the umbrella of a project financing mechanism known as PIDIREGAS[16], which had two basic components: international debt contracted via a special-purpose vehicle located in the USA known as the "Project Funding Maser Trust", which raised funds using accounts receivable from productive projects as collateral, and the direct financing of PEMEX contractors. This financing mechanism came to an end

[14]Chinese investment took place, and Petroamazonas was created.

[15]http://www.ri.pemex.com/index.cfm?action=content&sectionid=19&catid=12168

[16]On December 21, 1995, Article 18 of the Public Debt Law ("Public Debt Law") and Article 30 of the abrogated Federal Public Budgetary, Accounting and Expenditures Law ("FPBAEL") were amended to create a new category of long-term contingent public debt to support priority infrastructure projects that would generate revenue for their own funding, creating the Deferred Impact Status Projects or PIDIREGAS - "Proyectos de Infraestructura Productiva de Largo Plazo (PIDIREGAS)."

with the swearing in of President Calderon in December 2006, which put a ceiling on PIDIREGAS debt, directly affecting PEMEX investment capacity in 2007. Following this first measure, and amid concerns over the growing debt obligations of PEMEX, the Mexican Congress, in October 2008, unanimously approved amendments to the Federal Budget and Fiscal Responsibility Law that limited PEMEX's participation in the Deferred Impact Status Projects or PIDIREGAS, which had until then provided a mechanism for off balance sheet financing of infrastructure development projects by PEMEX.[17] By 2006, the PEMEX PIDIREGAS debt reached $52 billion. As part of the fiscal overhaul undertaken by the Calderon administration in response to economic conditions in Mexico, which had as a cornerstone the elimination of PIDIREGAS, PEMEX investment in Production Infrastructure dropped by 20% in 2008 after growing at an average annual rate of 17% between 2001 and 2007. The severe cuts to investment go a long way toward explaining the largest drop in PEMEX production, which began in 2005. Production dropped 290 mbd or 9.4% in 2008, more than the accumulated drop in 2006–2007 of 250 mbd. This limiting factor came on top of other well-known PEMEX limitations related to access to technology and engineering capacity to sustain production from existing fields and to tap potential oil-bearing territories.[18] However, in the short run the most limiting factor was the constraint on PEMEX investment capacity brought about by the new government sworn in in December 2006.

Throughout the period under analysis, PEMEX's finances remained under severe government control. The government permanently expropriated the company's operational surplus. Up until 2006, investment grew, financed by growing foreign debt. After 2006, the surplus squeeze translated into sharply falling investment and production. In terms of our schematic framework, México moved from the northwest quadrant to the northeast quadrant in the period under analysis.

The sharp deterioration of the Mexican oil sector has brought about a radical institutional reform in 2013-14 to open up the sector to private investment, technology and engineering capacity.

Venezuela: PDVSA was created as a fully state-owned company under private law.

[17]As a result of these amendments, (a) PEMEX Investment Expenditures were no longer counted for purposes of balancing the federal budget, thereby releasing additional government funds for other priority projects; (b) PEMEX's current PIDIREGAS commitments were now considered direct public debt rather than contingent debt obligations; and (c) PEMEX was not permitted to undertake further PIDIREGAS authorizations and projects. "Reforms to the PEMEX-PIDIREGAS Regime" White & Case 1155 Avenue of the Americas New York, NY 10036- February 2009

[18]The sharp drop in the Cantarell field after 2005 is explained by both mismanagement of the field and investment below the required standards.

This explains part of its success from its inception in 1975 until 1998 (Espinasa, 2010). The company's relationship with government was at arm's length, with shareholder meetings at least twice a year to approve the annual budget and yearly results, and no government interference on operations. The company was professionally managed. On top of being a world class state-owned company, the sustained expansion of capacity by more than 50% in the last decade of the century was supported by the opening to private investment, including the largest oil companies in the world, either as operators for PDVSA in marginal fields or in association for the development of world class projects to develop and upgrade the country's huge heavy crude reserves base.

The success story of the Venezuelan oil sector beginning with nationalization came to a sudden end with the swearing in of President Hugo Chavez in February 1999. A number of landmarks signaled the demise of the Venezuelan oil sector starting in 1999. First, growing government interference in the operational management of PDVSA from the appointment of managers and technical experts on the basis of political alliance rather than professional merits, to the diverting of company resources to non-oil related government activities, and most importantly, there was always greater discretional distribution of oil revenue to government at the expense of oil sector investment. Second, the new hydrocarbon law passed by congress in 2002 opened the door to different forms of government intervention in management of the oil industry and reduced opportunities for private participation. Finally, a number of international companies that refused to operate under the new rules were expropriated in 2005, and a large number of national companies providing services to PDVSA were expropriated in 2007. The decimation of PDVSA and the severe constraints to private investment may well explain the sustained decline in Venezuelan oil output over the last fifteen years.

During the period under analysis, the oil sector in Venezuela underwent a severe institutional transformation, though maintaining state monopoly control of production. PDVSA began as a state-owned monopoly under private law with an arm's length relationship with government, but eventually came under full government control, both operationally and financially. In terms of our schematic framework, PDVSA moved all the way from the northwest quadrant to the northeast quadrant.

Group I Summary:

During the period under analysis, all Group I countries underwent institutional changes that deepened discretional government interference in the management of the state-

owned sector. We have attempted to depict the evolution of the sector during this period according to the parameters we developed in the theoretical analytical framework.

Argentina: From private direct investment and minimal government intervention to state ownership and stringent government control.

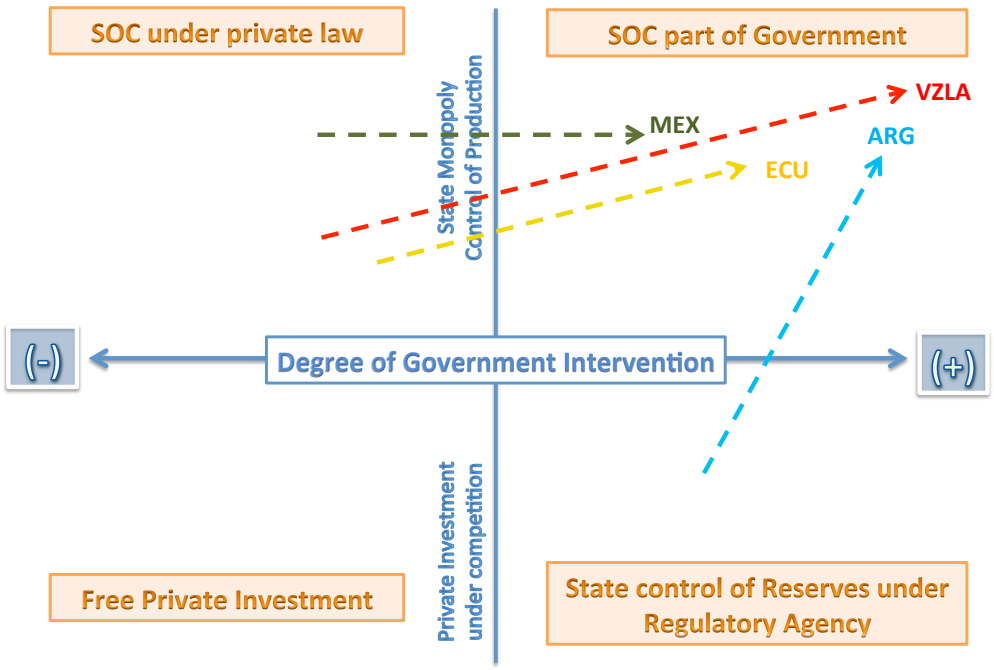
Ecuador: From state ownership and growing private participation to growing state and government control. Recent foreign selected investment.

Mexico: Permanent government financial control under full state ownership.

Venezuela: From state monopoly control with government control at arm's length and production in association with private capital to full government control of production and selected private participation.

In terms of our schematic framework, these four countries evolved toward greater government control along the period under analysis, as shown in Figure 15.

Figure 15



Source: Author's elaboration

Group II

The key distinctive feature of the Group II countries in Latin America is minimal direct government interference in the running of the oil industry, with private participation in competition with state-owned companies under a regulatory agency. The countries with private direct access to production in Latin America all operate under regulatory conditions set by the state. During the period under analysis, two of the three countries in the group, Brazil and Colombia, underwent radical sector reform that had as a cornerstone the creation of an independent agency to regulate oil production and open the sector to direct private investment. In Peru similar reform took place prior to the period under analysis. In contrast to the other countries in this group, in Peru the state-owned company does not participate in the upstream-production segment of the oil industry.

The countries in Group II can be classified into the second of the two families of countries identified in the analytical framework. Within the second family, the three countries can be classified within the second subfamily. All the countries have a similar institutional framework and industrial organization and, for the reasons argued in the framework, should perform better than the countries in Group I.

Brazil: The institutional framework of Brazil's oil sector underwent a key reform in August 1997 with the creation of the National Petroleum Agency (ANP) during the term of President Fernando Henrique Cardozo, which began in January 1995. Following the Norwegian model, Brazil created an independent regulatory agency to administer oil-bearing lands and oversee hydrocarbon operations in the country. This institutional reform had several consequences that improved the oil sector's response to market signals. First, the consequences on PETROBRAS: it freed the state-owned company from its role as administrator of the reserves, allowing the company to focus on the core oil business. This also allowed PETROBRAS to behave as a true limited liability company under private law and sell shares to private investors without putting in jeopardy the ownership of the reserves administered by the ANP on behalf of the state owner. Eventually PETROBRAS would be traded internationally in the major world stock exchanges. This opened PETROBRAS to public scrutiny and made the company accountable to stakeholders that pressed for improved performance. Finally, opening PETROBRAS to private investment increased the financing sources available to the company over and above its own cash flow and public sector financing. Second, the reform opened the Brazilian oil sector to direct private investment, particularly from

foreign companies operating alone, not in association with PETROBRAS. This second component of the reform had a number of consequences for overall oil sector performance; first and foremost it induced competition and thus led to growing efficiency in the oil sector. Opening to private capital gave Brazil's oil sector access to additional sources of financing, cutting edge technologies and know-how and enhanced engineering capacity. In terms of our schematic framework, Brazil moved from the northeast quadrant to the southeast quadrant in the period under analysis.

Colombia: Following the lead of Brazil and in view of the results of its new institutional framework, Colombia underwent a very similar reform in June 2003 under the presidency of Alvaro Uribe, who took office in August 2002. Colombia created the National Hydrocarbon Agency (ANH) to administer its oil-bearing territories. The results of the reform in Colombia were even more striking than in Brazil. Production had been falling for a number of years and the country was about to become a net importer, but by ten years after the reform, production had increased almost twofold, with a diverse and robust oil sector. The consequences of the reform were similar to those in Brazil. ECOPETROL was liberated from its role as administrator of the natural resource and was able to focus on the core oil business. The reform also allowed the company to incorporate private investors as stakeholders, subjecting the company to public scrutiny that pushed it toward increased efficiency. Opening the oil sector to private investment had a greater relative impact in Colombia than in Brazil. The contribution of private companies in terms of investment, know-how and engineering capacity in relation to the state-owned company was greater in Colombia than Brazil. In terms of our schematic framework, Colombia moved from the northeast quadrant to the southeast quadrant in the period under analysis.

Peru: The creation of an independent non-operating agency to administer the hydrocarbon-bearing territories in Peru precedes the similar reforms in Brazil and Colombia. It seems that the Peruvian government did not intend to follow the Norwegian model—the Peru model had a degree of originality. It also had very similar results to those that occurred later in Brazil and Colombia. The regulatory agency PERUPETRO was created by law when the most recent hydrocarbon law was enacted in August 1993 under the Presidency of Alberto Fujimori, who was sworn in in July 1990. There are some differences from the Brazilian and Colombian models; PETROPERU remains by law fully state-owned, although it is run under private law, competing with private companies particularly in the downstream business, but recently in the upstream as well. PETROPERU as a limited liability company is open to public scrutiny. Bear-

ing that difference, Peru's reform had the key ingredient of opening the hydrocarbon sector to private capital, both national and international. The stability of the country's institutions over the last two decades helped to boost large foreign investments in upstream oil and gas production. From being a net hydrocarbon importer, Peru has become a net exporter. Although the main success has been in gas production, the production of associated liquids has increased proportionally. In terms of our schematic framework, Peru remained in the southeast quadrant in the period under analysis.

Group II Summary:

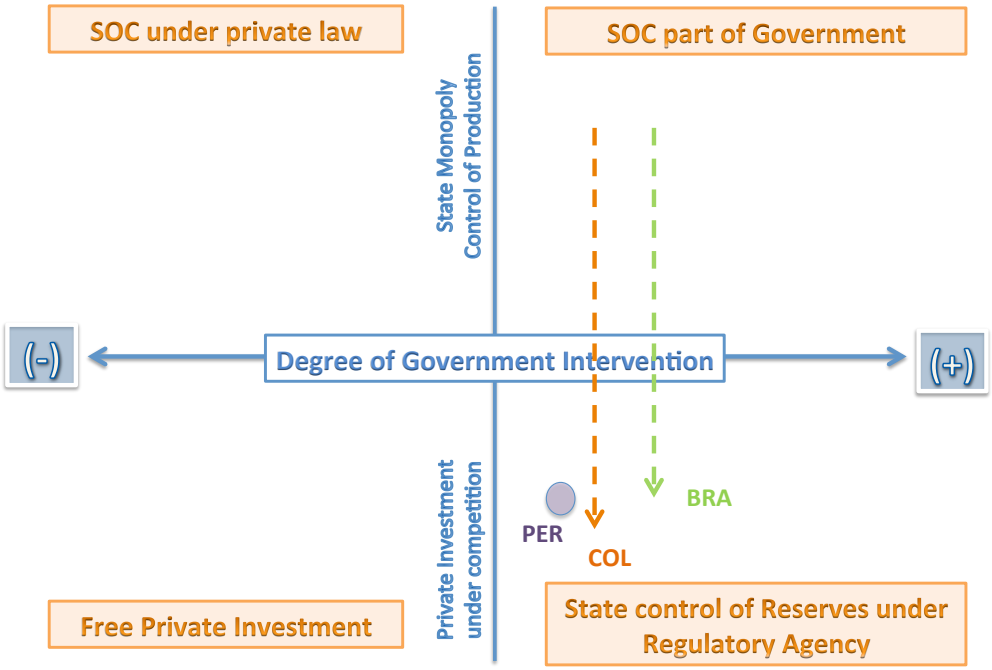
During the period under analysis, Brazil and Colombia underwent institutional changes with two similar features: they opened the oil sector to private investment and competition, and they opened the state-owned company to private investment under public scrutiny. In the case of Peru, a similar reform took place prior to the beginning of the period under analysis, with the only difference that the state-owned company was not opened to private investment. As with the countries in Group I, we have attempted to depict the evolution of oil sector reforms for countries in Group II during the period under analysis in Figure 16, according to the degree of state monopoly ownership and the degree of government interference in the oil industry. Brazil and Colombia moved from the northeast to the southeast quadrant, while Peru remained in that quadrant during the period under consideration.

Brazil and Colombia: From state monopoly control of production with contractual private participation to free private participation under regulation and private investment in the state-owned company.

Peru: Production remained under private control under regulation.

In terms of our schematic framework, these three countries evolved toward lesser government control a more competition along the period under analysis, as shown in Figure 16.

Figure 16



Source: Author's elaboration

Hypothesis Testing

The evolution of the oil sectors of the largest oil producers in Latin America over the last twenty years together with the break in the oil price trend give us the opportunity to formally test the hypothesis set forth about the relationship between institutional framework and performance.

With the exception of Peru, the other six largest producers underwent institutional changes associated with changes in the executive branch of government during the period beginning in 1995. In the four countries in Group I, the change brought greater government interference and/or a greater degree of state monopoly control of production. Colombia and Brazil underwent institutional changes during the same period, but toward lessening government interference and increasing direct private investment in competition with a state-owned company that was partially privatized. Peru had undergone these reforms just prior to the beginning of the period under analysis.

We should expect Group I countries' responses to price signals to become weaker or negligible, and should expect a positive response in Group II, in other words, deterio-

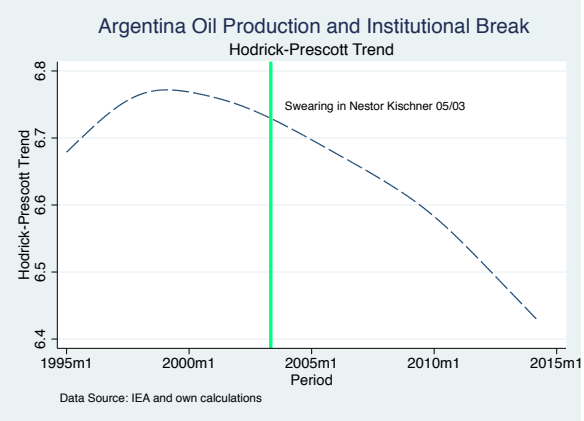
rating performance in the former and improving performance in the latter.

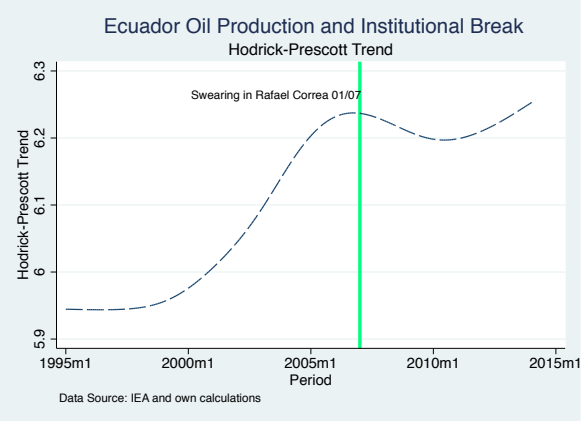
Figures 17–20 show trends in production in the Group I countries between 1995 and early 2014, as well as the institutional change marked by the swearing in of the president under whose government the oil sector institutional reforms were implemented. It can be seen that production decline accelerates after the reforms in spite of accelerating prices and the break in the price regime after 2002.

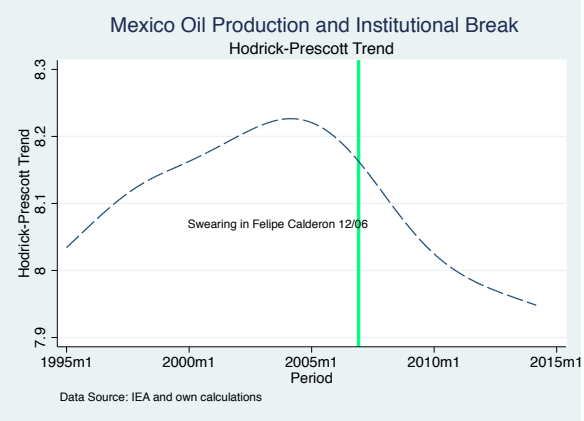
Figures 21 – 23 show trends in production in Group II countries and the institutional changes that took place with two landmarks: when the presidents that introduced reforms were sworn in and the date of the creation of the regulatory agency as the highlight of the reform. In the case of Peru, the reform falls before the period under analysis. It can be seen clearly that production responds to the reform in view of the positive break in prices during the period.

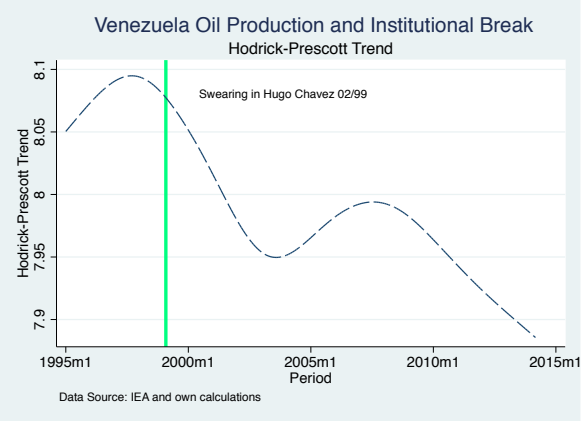
Group I

Figures 17 - 20



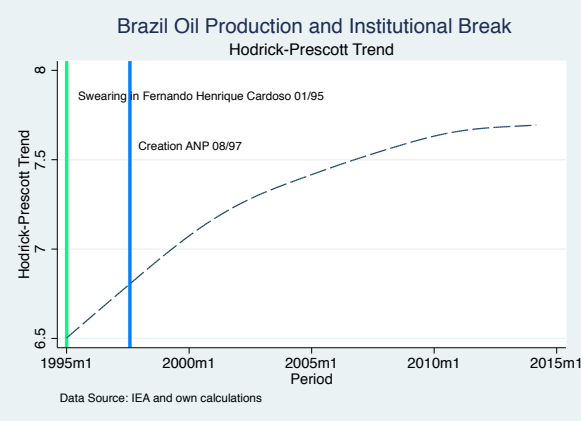


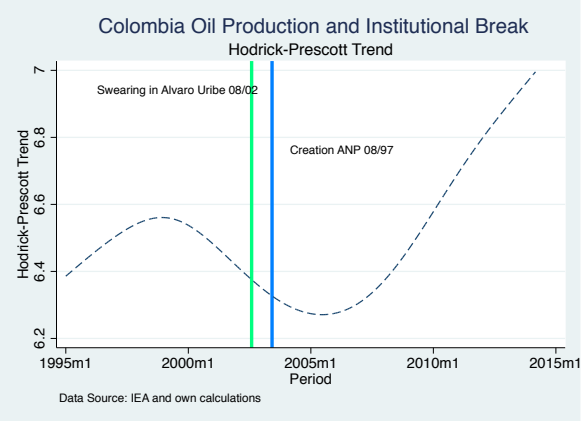


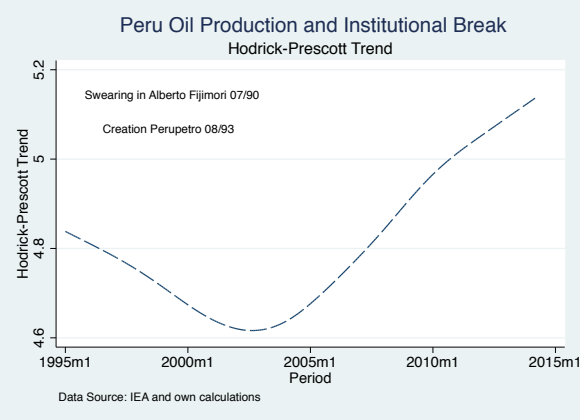


Group II

Figures 21 - 23







Testing the relationship between institutional change and oil sector performance. In order to test the relationship between institutional change and oil performance at the country level, we rely on the following specifications:

Before institutional change:

$$Y_t^i = \beta_0 + \beta_1^i P_t + \epsilon_t^i \quad \forall i, \quad for\ t\ \epsilon[0, t^*) \tag{1}$$

After institutional change:

$$Y_t^i = \beta_0 + \beta_1^i P_t + \epsilon_t^i \quad \forall i, \quad for\ t\ \epsilon[t^*, T) \tag{2}$$

Before and after:

$$Y_t^i = \beta_0 + \beta_1^i (I^i * P_t) + \sum_t \beta_t^i yr_t^i + \epsilon_t^i \quad \forall i, t \tag{3}$$

Panel test:

$$Y_t^i = \beta_0 + \beta_1 (K * I_{it} * P_t) + \sum_t \beta_t yr_t + \epsilon_{it} \tag{4}$$

Where Y refers to crude oil production, P represents the real international petroleum price, I is an indicator variable taking the value of 1 when the country adopts the institutional measures, and K is also a categorical variable adopting the value of 0 when the institutional change increased the discretional government intervention or 1 when the institutional change is market-oriented. As usual, t and i represent time and country, respectively; $t*$ represents the date when the country adopted the institutional change; and yr represents the year dummies. All continuous variables are $de-trended$ using the well-known $Hodrick-Prescott$ procedure in order to account for long-term relationships only.

The sign of the correlation between price and production will be country- and period-specific. For instance, before any institutional change, it would be expected that those countries with less discretional government intervention would have a positive correlation between production (Y) and prices (P). That is, β_1^i should be greater than zero. Conversely, the sign of the correlation should be negative with higher discretional government intervention. During the period under investigation, after the institutional change, those countries that increased the degree of government intervention are expected to have β_1^i less than zero, or greater than zero in the opposite case.

The interaction between the institutional change and prices is expected to capture the relationship of the structural break in oil prices given the change in the institutional environment. This effect is expected to be positive when countries move in the direction of pro-market reforms (Group 2) and negative when reforms are towards more government control (Group 1).

The interaction between institutional type, institutional change and price break ($K * I * P$) captures the correlation between performance and price break, given the type of institutional change. The coefficient of this interaction represents the average performance gap between those countries, with pro-market institutions outperforming those countries with a strong discretional government intervention. This gap is expected to be positive.

Table 1: Supply Performance vs. Price and Institutional change

	Group 1				Group 2			All
	ARG	ECU	MEX	VEN	BRA	COL	PER	Countries 2/.
Before								
Price trend	0.0501	**0.343****	**0.124****	**-0.783****	**-5.769****	**-0.398****	.	.
	(0.037)	**(0.003)**	**(0.010)**	**(0.026)**	**(0.023)**	**(0.032)**	.	.
Observations	85	144	143	49	32	103	.	.
Adjusted R-squared	0.01	0.987	0.51	0.95	0.999	0.6	.	.
After								
Price trend	**-0.238****	**-0.344****	**-0.964****	**-0.0649****	**0.536****	**0.617****	**0.177****	.
	(0.01)	**(0.01)**	**(0.01)**	**(0.01)**	**(0.01)**	**(0.05)**	**(0.02)**	.
Observations	119	60	61	155	172	101	204	.
Adjusted R-squared	0.848	0.973	0.988	0.486	0.942	0.571	0.382	.
Before & After 1/.								
Price trend*Institution	**-0.00284****	**-0.0916***	**-0.00529****	**-0.00487****	**0.0200****	0.00042	**0.228****	**0.235****
	(0.001)	**(0.050)**	**(0.002)**	**(0.002)**	**(0.004)**	(0.003)	**(0.032)**	**(0.014)**
Observations	204	204	204	204	204	204	204	1428
Adjusted R-squared	0.99	0.99	0.99	0.99	0.99	0.97	0.99	0.26

Robust Standard errors in parentheses

* p<0.10, ** p<0.05

1/. Year country specific effects

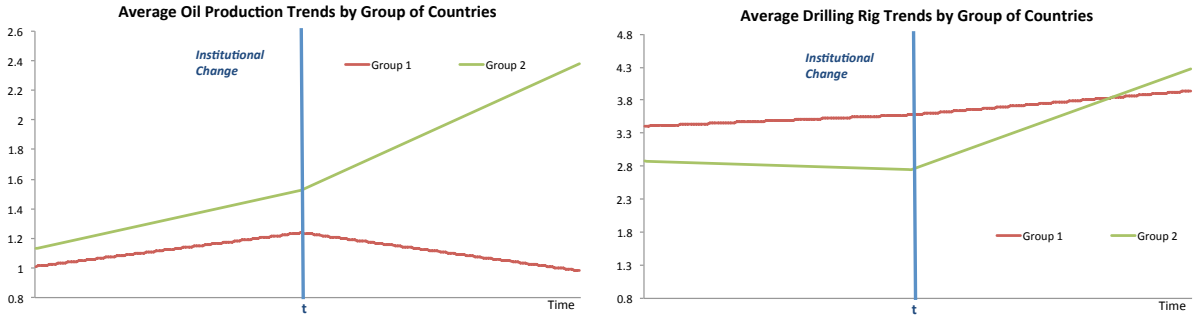
2/. Panel estimation

The drilling rigs are also expected to be a proxy of investment. However, as can be seen previously in the four countries that adopted more discretional government intervention, drilling rigs marginally increased while production sharply decreased or remained stagnant. In contrast, in those countries that adopted pro-market institutions, there was a pronounced increase in drilling rigs. This gap in performance measured by drilling rigs can be tested using a panel data regression. It is expected that those countries with pro-market institutions show a greater increase in drilling rigs than those countries with non-market institutions. The regression returns a coefficient of 0.197, statistically significant at 5%. This is consistent with the gap estimated in Table 1,

which shows a greater gap as a consequence of clear oil production decreases in the countries with more discretional government intervention and oil production increases in the countries with a pro-market environment. Thus, oil production seems to better reflect the performance of the sector.

Finally, as a graphical test of the relationship between institutional reforms and oil sector performance, we construct average indexes representing the trends of oil production and drilling rigs by country group (Figures 24-25).[19] As expected, the oil production trend in the Group I countries decreases after the reforms, while the Group II countries increase their production. Similarly, the trend in drilling rigs shows a sharp increase in Group II, while it is practically stagnant in Group I.

Figures 24 - 25



Source: Own elaboration

[19]Institutional changes were normalized across countries in the sample.

Concluding Remarks

We know that many factors play a role in successful development experiences in the oil sector worldwide. However, one element often emerges as the key variable for resource-rich countries to avoid falling behind: appropriate institutional framework.

We argue that the success of the oil sector depends heavily on the institutions and regulatory framework that govern the extraction of natural resources. Indeed, it is possible to sort the seven largest Latin American oil-producing countries into two groups with similar oil sector frameworks, yielding similar oil sector performance over the last nineteen years.

There is a first group of countries where the state exercises its monopoly property rights on the reserves by maintaining monopoly control of production through a state-owned company and through protracted government intervention in the operations of the companies, whether state-owned or private. The countries in this group are Mexico, Venezuela, Ecuador and Argentina.

In the second group of countries, the state exercises its monopoly property rights through indirect control of production by means of a National Oil Regulatory Agency which administers the oil bearing lands on behalf of the state owner. The agency opens up the territories with hydrocarbon potential for development by oil companies both national and international, and both privately and state-owned. The territories to be developed are auctioned off through a bidding process and awarded on the basis of different parameters, among others: the government take, the investment and production over and above minimum levels set up by the agency and the content of local goods and services over and above a set minimum. The countries in this group are Brazil, Colombia and Peru.

During the period under analysis, we witnessed an interesting experiment. At the beginning of the period, just one country, Peru, was open to direct private investment in the oil sector. Two other countries, Brazil and Colombia, changed their institutional framework during the period to allow for direct private participation in competition with the state-owned company under an independent regulatory agency. Finally, in four of the countries, Argentina, Ecuador, Mexico and Venezuela, the degree of government monopoly control of production increased due to different reforms associated with changes in government orientation throughout the period: Peru from the beginning, and Brazil and Colombia after their respective reforms showed positive performance. On the contrary, performance in Argentina, Ecuador, Mexico and Venezuela worsened after

reforms that increased the degree of government control of production.

In a price-taker oil producing country without barriers to investment in the sector, it would be expected that oil activity, as measured by oil output and number of drilling rigs, would increase following the permanent quantum leap in prices after 2002. However, the reaction was not positive and homogeneous in all oil-producing countries in the region. Three countries in effect permanently increased drilling activity and production: Brazil, Colombia and Peru. In contrast, in Mexico, Venezuela, Ecuador and Argentina, drilling activity remained stagnant and production declined over the last decade.

In our paper we have demonstrated two facts. First, in the analysis across countries, the less competitive the oil sector is, as defined by the institutional framework, the worse the performance is, as defined as the response to price signals. Second, for the same country, a change in the institutional framework leading to more government control leads to worsening performance, while reforms that produce more competitive environments improve performance.

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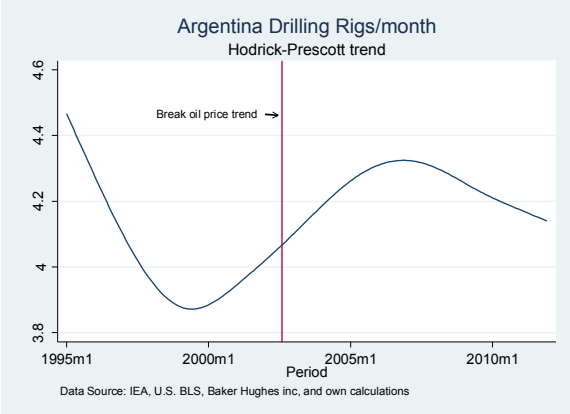
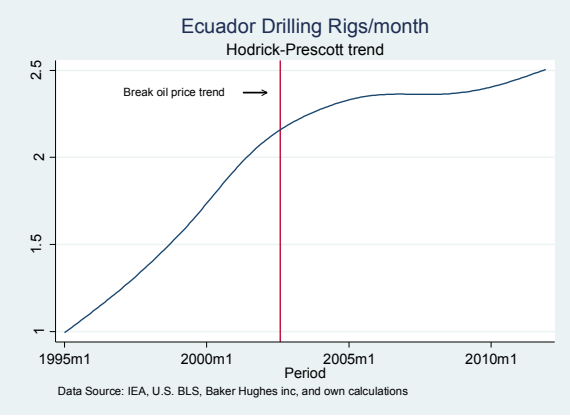
Appendix

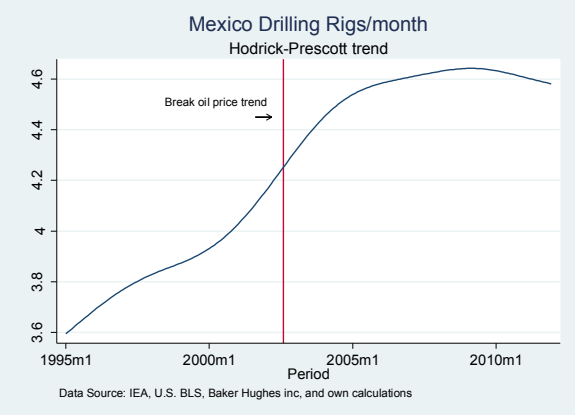
Group I vs Group II: Despite oil prices oil prices increased almost fourfold in real terms, from about 26 per barrel ($/b) in 1995 to 94 ($/b) by the end 2013, LAC oil producers reacted differently. Group I (Argentina, Ecuador, Mexico and Venezuela) and Group II (Brazil, Colombia and Peru).

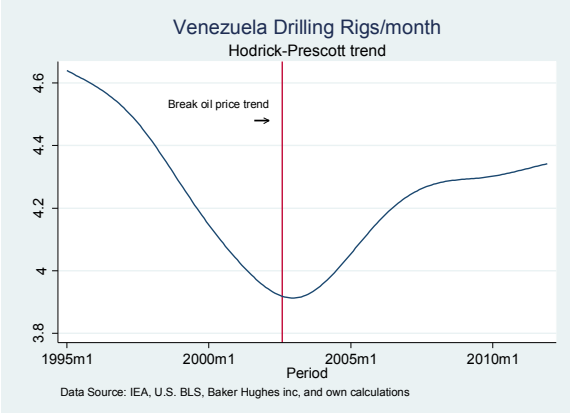
Drilling Activity

Group I (Poor performance, drilling activity remained stagnant despite oil price increases): Argentina, Ecuador, Mexico and Venezuela.

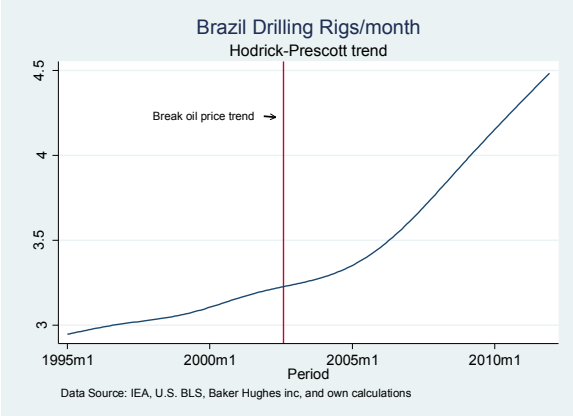


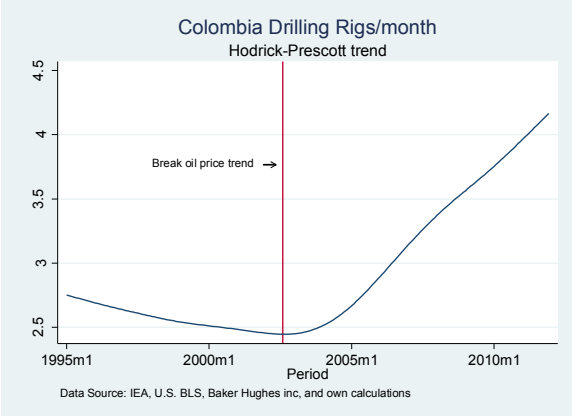


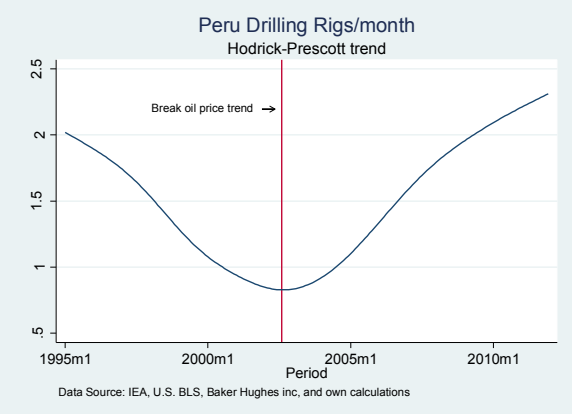




Group II (good performance): Brazil, Colombia and Peru

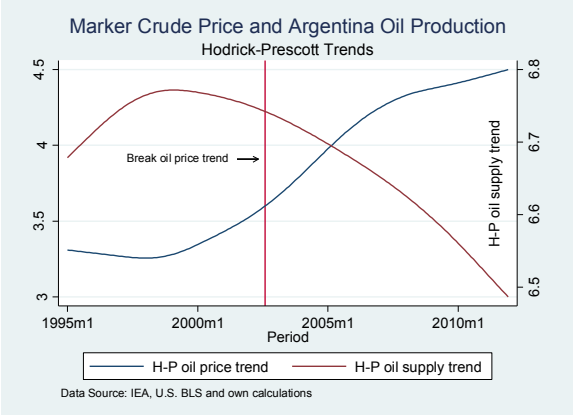


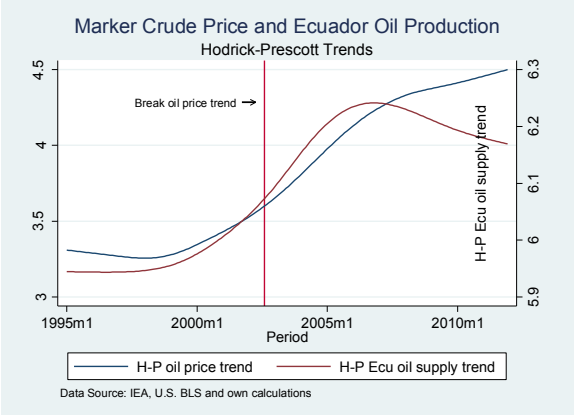


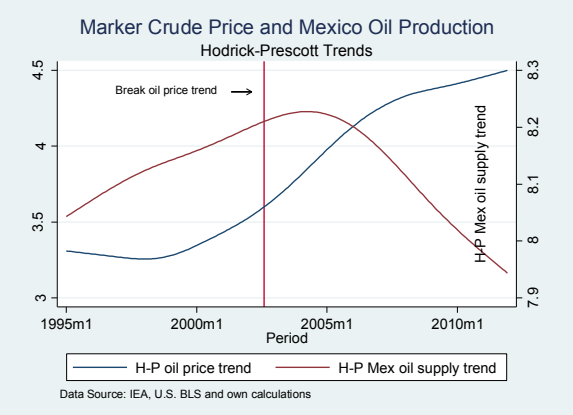


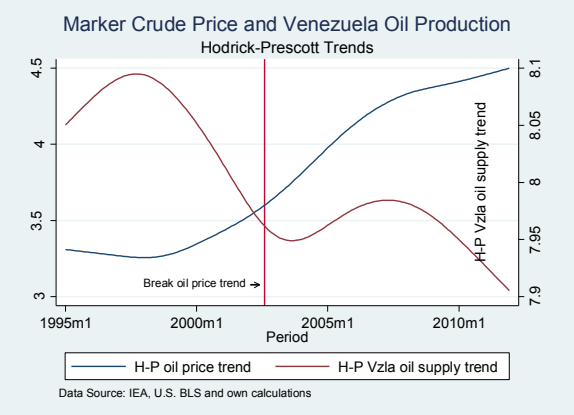
Price Signals and Supply Performance

Group I: Argentina, Ecuador, Mexico and Venezuela









Group II: Brazil, Colombia and Peru