Determinants of Auction Design in Allocating Oil and Gas Licenses

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Author's Declaration

I, the undersignedhereby declare that I am the sole author of this thesis. To the best of my knowledge this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted as part of the requirements of any other academic degree or non-degree program, in English or in any other language.

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Abstract

This thesis explores how the policy goals and preferences of state actors affect the design of auctioning systems in the petroleum industry. States routinely use auctioning systems to allocate exploration and production (E&P) licenses to exploit their oil and gas resources. How they design this process will directly affect international oil companies (IOCs) behaviour towards E&P activities, and consequently, the original policy goals and preferences of the state. This thesis will identify which policy goals and preferences of state actors translate into which auction rules, and how these translate into specific behaviours of IOCs. Using Rational Choice Institutionalism (RCI) as a guide, this thesis focuses on the preferences of state actors, the rules surrounding the institution of auctions, and the behaviour of IOCs interacting with the various auction systems. Using this approach, this thesis demonstrates that close examination of state actors policy goals and preferences can beused to anticipate 'basic' auction designs; however, the case study of Brazil's and Venezuela's petroleum industry demonstrates the theories inability to predict beyond 'basic' auction designs because of the complexity of state preferences that can be easily reflected in the design of auction systems.

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List of Figures and Abbreviations

E&P – Exploration and Production IOC – International Oil Company NOC – National Oil Company PDVSA – Petroleos de Venezuela S.A. PSC – Production Sharing Contract RCI – Rational Choice Institutionalism

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Introduction

In this thesis I will discuss how state actors policy goals and preferences affect the design of allocation systems for exploration and production (E&P)licenses in the petroleum industry. The majority of states allocate E&P licences through a range of auctioneering systems where international oil companies (IOCs) compete against each other by offering various forms of rent. These auctioneering systems incorporate mechanisms that are meant to freely choose IOCsbased upon pre-established rules. To understand why states choose one auctioneering system over another, this thesis will explore the effects of different auction systems on IOCs' behaviour and how this shapes states policy choices. This thesis will demonstrate how state preferences towards specific policy goals will result in different allocations systems for E&Plicenses.

To analyze this process, this thesis will focus on the policy goals and preferences of state actors, the rules of different auction designs, and the behaviour of IOCs. To do this, this thesis will rely on the theory of Rational Choice Institutionalism (RCI). This theory will narrow the scopeof research to focus on the institution of auctions and the players that surround them. Research will focus on identifying the policy goals and preferences of state actors and how these contribute to shaping the rules of auctions. It will also focus on the interaction of IOCs with different auction designs and how their behaviour is shaped by different sets of rules.

Auction designs can be broken down into two main features: "what" is being auctioned and "how" is it being auctioned. In the case of E&Plicenses the "what" represents forms of rent*inter alias*ignature bonuses, work programs, profit sharing, royalty rates or a combination of rents. For the "how" there are two main types of auctions: open or sealed. Within both of these types of auctions there are simultaneous and sequential auctions. Many variations of auctions exist in addition to these types; however, the basic framework for auctions begins with the decision to choose open or sealed, and simultaneous or sequential. This thesis will review the literature on the basic framework of auctions in the oil and gas industry while attempting to link policy goals and considerations with the policy implications of each auctioneering system.

Using Brazil and Venezuela as case studies; this thesis will demonstrate how state preferences can be linked with auction design. Both of these stateshave opened up their oil and gas industry in the past two decades after long histories of protectionism. Both states have also experienced leaders with different preferences that have resulted in diverging paths for their oil and gas industry. This has resulted in different sets of rules being used in their auction design.

This thesis is organized in three main chapters. The first chapter gives a brief overview of the research methodology and a detailed description of Rational Choice Institutionalism. The second chapter focuses on the existing literature pertaining to auction designs in the oil and gas industry and the theory of auctions in general. This chapter is broken down into two main components: "what" is being auctioned and "how" is it being auctioned. The third chapter focuses on the case study of Brazil and Venezuela. Finally, some policy implications will be explored and some concluding remarks are presented.

Chapter 1: Methodology and Theory

Research Process

This thesis began with the question of how states determine the type of auction system they use to allocate E&Plicenses. The initial wide scope of the literature review was narrowed to focus specifically on the institution of auctions using the theory of Rational Choice Institutionalism (RCI). Using RCI, this thesis could limit its scope and focus on specific areas such as the preferences of state actors, the design of auction systems, and the behaviour of IOCs. Once the literature review was completed, state preferences were linked to auction designs. These linkages were then tested against two case studies where the auction systems were unknown and the geo-political environments in both states were similar.An evaluation of the linkages against the case study was conducted, possible policy implications were explored, and finally, some concluding remarks are presented.

Rational Choice Institutionalism

The objective of this thesis is to study how policy goals and preferences of state actors affect the design and structure of oil and gas auctions, and consequently, what effects this has on the behaviour of IOCs. The designs of oil and gas auctions are representative of the preferences of state actors and the outcomes they are trying to achieve. These outcomes depend on how IOCs interact with the rules of auctions and the strategies they are likely to employ in order to achieve their own goals; therefore, the goal of this thesis is to identify which policy goals and preferences of state actors translates into which auction rules – the causes – and how these translate into specific behaviours of IOCs –

the effects. To do this, this thesis will rely on the theory of Rational Choice Institutionalism (RCI) to analyze the institution of E&P auctions.

RCIfocuses on the actors, preferences, and rules that surround institutions. This theory argues that institutions are shaped mainly by the preferences of state actors, rather than historical trajectories or pre-established sociological norms. In the RCI literature, Peter Hall (1986, p.20) defines institutions as "formal rules, compliance procedures, and standard operating practices that structure relationships between individuals in various units of the polity and the economy." Searle (2005, p.21) uses a broader definition, arguing that an institution can be any "… collectively accepted system of rules that enable us to create institutional facts." Institutions *raison d'etre* is to reduce transaction costs associated with a particular act (Hall and Taylor, 1996, p.943), and they generally serve two main functions according to Moe (1990, p.214): they help solve collective action problems, and they help with redistribution by choosing winners and losers.

In this thesis the institution of focus is the auctioning system, the designers are state actors within the government, the players are the IOCs, and the redistribution pertains to the rights for E&P over state oil and gas resources. RCI assists in demonstrating how auctions determine outcomes that state actors evaluate in order to change the rules of the auction to suit their preferences (Katznelson and Weingast, 2005). The determination of winners and losers provides valuable information for state actors who design the institution. This information results in less uncertainty regarding outcomes from the

institution and the strategies the players are using, which in turn, helps shape future rules to further meet their preferences (Hall and Taylor, 1996, p.951).

RCI allows scholars tonarrow the number of possibilities of policy decisions state actors are likely to make at the micro-level, based on their ability to identify pre-determined preferences that maximize their utility (Bevir and Rhodes, 2001, p.4). This assertion is founded on the ability of scholars to make the correct assumption on how actors rank their preferences or what would maximize their utility (Katznelson and Weingast, 2005, p.8). The ranking of these preferences can then be linked to the design of an institutionand its future outcomes. In this case, the outcomes are how IOCs react towards the various sets of rules that accompany the different auctioneering systems and the types of bidding strategies they utilize.

This relationship between rules and preferences has evolvedover the past quarter century. Ostrom (1986) in her article*An Agenda for the Study of Institutions* argued that rules "defin[e] a structured situation." Defining the situation would limit the amount of possibilities that could occur but would not provide any additional information towards predicting actors' behaviour. More recently, however, Katznelson and Weingast (2005, p.10) argue that although preferences may not be inherent in individuals, the rules of institutions can shape preferences for those players who must play by them, and hypotheses allows predictions to be made and then tested through empirical studies. This thesis will make linkages, based on if specific preferences of state actors can be correlated to certain auction designs, and consequently, IOCs' behaviour.

To generate linkages between the causes and effects of auction designs, RCI must explore the rules and strategies of players. Hall and Taylor (1996, p.945) emphasize "the role of strategic interaction in the determination of political outcomes." Actors who interact with institutions will act strategically, learning from other actors, and changing their preferences based on the most present information. Katznelson and Weingast (2005, p.8) also state that actors will change their strategies based on the circumstances surrounding transactions and the strategies of others. These strategies will be guided by the rules of the institution; therefore, state actors may have to adjust their auction design based on how IOCs behave to the new rules.Ostrom (1986, p.7) states that rules have three purposes: to forbid actions, to place limits surrounding an action, or to require an action. In the case of oil and gas auctions, rules can constrain or forbid the number of IOCs voting on a block, place minimum price levels, or ensure winners conduct specific levels of E&P. Regardless of the rules put in place, Hall and Taylor (1996, p.944-5) stress that players will "behave entirely instrumentally" when it comes to meeting their own preferences, and that they will act in a "highly strategic manner that presumes extensive calculation." The challenge for state actors designing institutions is to try and shape the behaviour of actors even if their preferences are contrary to the states. Using the RCI framework and the information presented above, the following literature review will focus on the various rules, goals, preferences, and strategies of both state actors and IOCs in the auctioning process of E&P licenses.

Chapter 2: Bid Components and Auction Processes

The primary focus of this thesis is on auctioneering systems for allocating E&P licenses, but it is important to recognize that auctions are not the only method used by state actors to permitoil and gas activities. Some states use completely discretionary systems, where blocs of land are allocated through a system where the state receives proposals from IOCs that are evaluated based on pre-defined criteria. The final decision is not based on a market mechanism or a formula but on the discretion of state actors. This process is used in Norway and is outlined in much more detail in Sunnevag's (2000) article. In some states with national oil companies (NOCs), they do not need assistance from private IOCs and can develop their resources independently. In other circumstances, the NOC may partner with IOCs in operations where they lack expertise or the technological capability. In these cases IOCs would be chosen primarily on their qualifications, with financial details coming as a secondary matter of importance. In addition, as NOCs are becoming larger and more prominent they are increasingly partnering together with other NOCs to develop oil and gas resources.

Forms of Rent being auctioned

The ultimate objective of IOCs entering an auction is to win an E&P licence for a predefined block of land. Winning a license gives the owner the sole authority to conduct exploration activities, and if successful, develop the bloc for production. A license will define the geographic boundaries of the block, the terms of E&P, and possible royalty or tax rates. To win a license, IOC's will need to compete against each other during an auction. The end goal of winning an E&P license may be the same in all auctions, but what forms of rent IOCs use to bid against each other will likely be determined by the preferences of state actors.

There are four prominentforms of rent that states can choose to be auctioned in E&P licenses: signature bonuses, work programs, profit/production sharing, and royalty rates. Before this thesis breaks down each of these forms of rent, there are a few pieces of information worth noting. Surrounding any auction dealing with E&P licenses there is a level of uncertainty pertaining to the block area. To decrease this uncertainty, IOCs routinely conduct *ex ante* exploration activities using seismic surveys that help determine the geological structure of the licensed bloc (Kretzer, 1994). IOCs who own neighbouring blocs may also have additional privately held information at their disposal, since they may have already drilled nearby wells or have done extensive seismic surveying in the past. These factors create information asymmetries between IOCs that will affect their behaviour during the bidding process. It is important for state actors to analyze this behaviour, as it will likely provide crucial information about the value of the block, which state actors would otherwise not know because of the gap in expertise between themselves and the private IOCs (Sunnevag, 2000; Leland, 1978).

Signature Bonuses

Signature bonuses are upfront transfers of money from IOCs to the state in exchange for an E&P license. This form of rent extraction allocates the license to whoever is willing to pay the highest amount. In its simplest form the IOC evaluates the potential future value of the license and submits a bid that represents the highest purchasing price it is willing to pay. This form of rent extraction is the most basic to administer by the state and the least costly in terms of administration because there is no long term monitoring costs due to its upfront nature (Mead, 1994, p.8). The signature bonus is also considered to be very investor friendly for IOCs (Mead, 1994; Cramton, 2007; Sunnevag, 2002). The upfront cost acts as sunk cost that does not distort future investment decisions regarding exploration or production (Sunnevag, 2002, p.51). For states, it also provides upfront financial gains that can be quickly collected and oftentimes beextremely lucrative. For instance, in the 1968 Prudhoe Bay auction the Alaskan government received \$900 million for one E&P license (Alaska Permanent Fund, 2009). The United States government also predominantly uses signature bonuses to allocate E&P licenses offshore in the Gulf of Mexico.

State actors must be weary of using signature bonuses, especially if they wish to enact a "pure" signature bonus regime. Although some scholars such as Mead (1994) believe that "pure" signature bonus regimes are the most efficient method of allocating rent, many other authors are cautious about this approach such as Leland (1978), Cramton (2007), and Tordo *et al* (2010). Mead argues that signature bonuses accurately evaluate the net present value of the resource in addition to reflecting the "risk-adjusted present value of avoided future royalty payments" based on all the information available (1994, p.6). He argues that since no rent will be extracted *ex post* the signature bonus, all exploration and production decisions will be more efficient, resulting in more oil being produced. This is a consequence of what he terms the "abandonment problem," where companies willproduce up to their marginal cost unless they have to pay royalties, which means a

higher marginal cost limit, a shorter production period, and more oil being left in the ground.

Tordo *et al* (2010, p.35) acknowledge the distortionary effects of back-end rent extraction regimes but argue that the uncertainty that comes with not knowing the true current or long-term value of the block is reason enough to avoid a "pure" signature bonus regime. In addition, Sunnevag (2004, p.4) states that auctions should focus on efficiently allocating licenses and not on rent extraction, as Mead suggests. LeLand (1978) recognized the downside of this approach thirty years ago when he uncovered that IOCs were becoming risk averse, and as a consequence, began discounting their bids for oil leases. Cramton (2007, p.127) also argues that a pure signature bonus system is only preferable if there is full certainty about the value of the resource, since this is the only way the market can efficiently allocate both buyers and sellers when full information is present.

Work Programs

Work programs are proposals oil companies submit to governments outlining their plan for exploration in a bloc being auctioned. The primary goal of work programs is to spur exploration activity in underexplored blocs or "frontier" regions (Kretzer, 1994). A bid would include the amount of money they are planning to spend, the types of exploration activities they are choosing to conduct, the companies' technological capability and any expected environmental impacts. State actors predominantly evaluate bids based upon the amount of exploration activities they are willing to conduct; therefore, the highest bidder generally wins the bid. However, state actors may reject the high bid based upon technological or environmental concerns (Tordo et al, 2010, p.14).

Promoting exploration through work programs may also create investment distortions depending on the geology of the region and the political risk perceived by the IOC. States who use work programs to allocate oil and gas licenses may be discouraging pre-bidding exploration activities. Kretzer (1994) demonstrates that there may be no advantages of conducting pre-bidding exploration activities in costly regions because even if the IOC determines the likelihood of an oil field, it will still have to outbid other companies regardless if more exploration is needed. Essentially, Kretzer argues that work programs misallocate capital where it may not be needed, and this is compounded during competitive blocs where "overcapitalization" can occur due to aggressive bidding. In the case of a winning bid, early drilling results may uncover that the work program submitted poorly reflects the types of activities needed to explore the block or that they have committed to exploration activities that are likely futile (Mead, 1994, p.7).Work programs are also rarely used as the sole rent extraction mechanism. Sunley et al (2003) state that when there are high levels of uncertainty or political risk, bids will generally be lower; therefore, in the case of a large oil discovery states must resort to extracting rent on the back end of the E&P cycle.

Profit/Production Sharing Contracts and Royalty Rates

Two similar forms of rent that can be auctioned are profit/production sharing contracts and royalty rates. In this case, IOCs compete against each other to see who is willing to provide the most favourable terms to the state, either in the form of profits, production or royalty rates. For instance, an IOC may be willing to offer 80% of the profit oil once capital costs have been repaid, 65% of the oil produced, or a 50% royalty rate per barrel based on international oil prices. These rates are generally supplemented by a long list of terms and obligations surrounding the process in order to define when profits arise and to determine when the royalty rate is applied.

Profit sharing arrangements reduces risk for IOCs and limits distortions in production decisions. IOCs benefit from profit sharing arrangements because there is less risk involved in recovering capital costs since rent extraction only occurs once profit oil has been achieved, therefore, the rent is recovered on the backend of the E&P cycle limiting distortions in E&P decisions (Cramton, 2007, p.127). The rent can be extracted in the form of profits or through production sharing contracts(PSC) where physical barrels of oil are transferred to the state after extraction (Johnston, 2007, p.61). The decision to receive a percentage of the profit or a percentage of production is likely decided by state actors' policy goals. For instance, keeping domestic oil prices low could be achieved by using a PSC. There are also some downfalls with allowing IOCs to apply capital costs against profits. Some companies may try to transfer expenses to more profitable operations in order to lower the amount of profits they must transfer to the state. Sunnevag (2000, p.8) encourages states to ensure they have strong "ring fencing" agreements that prevent IOCs from applying costs associated with other operations against more profitable projects.

IOCs may also bid against each other, offering the highest levels of royalty rates. This is a type of tax IOCs transfer to government per barrel of oil produced based on present day market prices. Using this type of rent extraction prolongs payment to government until the IOC has reached profit oil. This results in higher administrative costs compared to signature bonuses because the state must review all capital costs and production figures to ensure the state is receiving its fair share. This type of rent extraction has less risk than signature bonuses for IOCs because payments to government are only necessary when production is achieved and generally only begins once capital costs have been repaid; therefore, if costs run high or no oil is found then no royalties must be paid.

Summary of State Preferences and Forms of Rent

The choice between what form of rent IOCs will use during bidding procedures can be linked to the preferences of state actors. In the case of signature bonuses this form of rent extraction provides upfront and potentially huge financial gains to the state. State actors whose policy goal is to quickly extract rent from the state's oil and gas resources may find this form of rent desirable. This form of rent extraction also has low administration costs and is perceived favourably by investors because of its efficiency, sunk costs, and ability not to distort production decisions. However, it also poses high risks for the state because of asymmetries of information with the IOC. In many cases it is impossible to know how much oil the bloc likely contains or what future oil prices will be, which means the true value of the bloc is unknown; therefore, the state may receive a signature bonus that under or over values the bloc. In the case of work programs, state actors who wish to pressure IOCs into exploring and investing in underexplored or frontier regions may find this form of bidding more preferable. There are many investment and capital distortions associated with this form of bidding, but these are concentrated on the side of the IOC and not the state. Although, the state must endure higher administration costswhen using work programs because of the difficulty and duration in overseeing all the activities of the IOC implementing the work program. This form of rent is almost always used in combination with other rent extraction mechanisms because it does not extract rent from the production of oil and gas resources, it merely entices them to conduct more exploration activities.

Profit sharing and royalty rates push the rent extraction from IOCs to the back end of the E&P cycle. This form of bidding reduces risk for IOCs because rent extraction is based on profits and generally occurs after profit oil has been achieved. This form of bidding also provides more certainty for state actors that they will receive fair market value for their resource, as rents will reflect current market prices for the resource. It also provides flexibility for state actors to decide whether to receive profits, royalties, or physical barrels of oil based on their policy goals. For instance, state actors could tie profits to popular state programs, use increased royalty rates as a means of garnering public support, or use the physical barrels of oil to subsidize domestic fuel prices. These types of rent extractions have the highest administration costs; however, these costs will likely be minimal compared to the potential gains of exploiting oil and gas resources. A summary of the forms of rent and linkages is provided in Diagram 1.

Diagram 1: State Preferences in Forms of Rent				
Signature Bonuses	Work Programs	Profit/Production/Royalty Contracts		
 Promotes pre- bidding exploration Upfront financial gains Low Administration Costs Low efficiency for allocation because true value of bloc is usually unknown 	 Discourages pre- bidding exploration Promotes exploration in underexplored or frontier regions Higher administration cost Rarely can be used as the sole rent extraction mechanism Creates investment distortions and potential overcapitalization for IOCs 	 Promotes pre-bidding exploration Delay of Financial gains till end of E&P cycle High administration and monitoring costs Provides flexibility for state goals Ability to receive to receive physical barrels of oil Limits production distortions, results in more oil being produced 		

Types of Auction Systems

Auction systems are mechanisms designed by state actors to efficiently and effectively allocate E&P licenses to IOCs in a fair, competitive, and transparent environment. Their design not only reflects the preferences of state actors but also the constant struggle betweencapturing rent and efficiently allocating the rights for E&P activities. Auctions can offer significant financial rewards to the state, as well asprovide valuable information pertaining to the value of the resource (Fraser, 1991). There generally exists an asymmetry of information between state actors and the private sector, with the latter being considerably favoured, especially in complex geological settings. It is for this reason Segal (2012, p.341) argues that the only way the state can receive the true market value of its resources is when the process is transparent and competitive. If revenue maximization is the number one goal of state actors, then these two components are crucial. Auctions must be open to all IOCs, announced well in advance, and all meetings between IOCs and the state must be made public, with issues discussed being disclosed (Cramton, 2007, p.119). In addition to these transparency measures, state actors have designed auctioneering systems with safety features that protect its interests and ensure that IOCs do not collude or gain licenses below an acceptable price level. For instance, states generally have reserve rates that are unknown to IOCs, which enables them to reject any winning offers that fall below the state's acceptability level (Ausubel and Cramton, 2004, p.482). This reduces the risk of IOCs colluding together to win blocs by selective bidding, whereby IOCs agree before hand who will bid, by how much, and on what blocs.

Sealed Bidding

Auctions where bidders cannot see each other's bids are considered sealed bid auctions. These auctions occur when IOCs independently evaluate the value of a bloc and then send in their bid to the state before a cut-off period. The state then evaluates the bids and chooses the highest bid unless that company fails to meet some other criteria. Kretzer (1994) found in his study that sealed bid auctions in the oil and gas industry spurred prebidding exploration and is a useful auctioneering system for any state whose goal is raising revenue. He found that IOCs independently conducted pre-exploration bidding to gain an information advantage over other competitors, which would result in more efficient evaluations of the potential resource. This type of auctioneering system is also useful when there is low competition because it forces IOCs to evaluate the bloc based on market prices and the uncertainty of other IOCs expected bids (Mead, 1994, p.11). During an open-auction, there is a higher chance an IOC can win a bloc through 'low balling' when there exists low competition for the bloc. Sealed bidding also reduces collusion because it is difficult to enforce or monitor conspirators.

Open Bidding

Auctions where bidders can see each other's bids are considered open bid auctions. These auctions can be ascending (English) or descending (Dutch), that is, the auctioneer may call out bids that either rise or fall in pre-established increments until there is only one bidder left in the auction. Auctions where the final bidder pays the second highest valuation are called second-price or Vickrey Auctions (Vickrey, 1961). Open auctions provide more information to the bidders, as they can view how other IOCs are valuing the

bloc (Bergemann and Said, 2011, p.4). This increased information creates a more "aggressive" auction, resulting in higher evaluations and more revenue for the state (Cramton, 2007, p.122). This type of auction also reduces the so-called 'winners curse' because IOCs will be bidding along side of each other and this reduces "common-value uncertainty" (Ausubel and Cramton, 2004, p.481).

Sealed vs. Open Bidding

When choosing between sealed or open bidding auctions, state actors must recognize that both can work well in particular environments. The challenge for state actors is to evaluate the present environment and how IOCs will likely react during the auction process. Authors like Maskin and Riley (2000) argue that expected pay-off for buyers in both types are equal, yet they acknowledge that some bidders prefer one type over the other based on their perceived competitiveness. For instance, strong bidders generally prefer a open auction because they have a higher probability of winning the bid at a lower price, as they only need to outbid weaker players by one 'bidding increment' to win the overall bid (Maskin and Riley, 2000; Goeree *et al*, 2006; Klemperer, 2002). On the other hand, weak players prefer sealed auctions as uncertainty surrounding some blocs may give them the opportunity to win a lease with a lower price.

Taking this into account, state actors must determine if a competitive environment exists, therefore, requiring an open bid auction or if there is low competition, requiring a sealed bid auction. In theoretical experiments, sealed bid auctions resulted in winning bids being significantly higher than the optimal price when compared to open ascending auctions,

where the winning bid either meets the optimal price or slightly surpasses it (Coppinger *et al*, 1980). In Andersson *et al's* (2013) laboratory study they found that the sealed bid auction worked best during one-time auctions, but that after multiple auctions the open bid auction was more preferable. Determining whether there exists a low or high competitiveness for a bloc will allow state actors to choose the type of auctioning system that provides the best possibility for maximizing their returns.

Simultaneous vs. Sequential Bidding

Depending on the competitiveness and the number of licenses up for auction, the state may choose to conduct simultaneous or sequential bids in either sealed or open auctions. First, lets focus on simultaneous sealed and open auctions. The main feature of this type of bidding is that multiple blocs are being auctioned simultaneously. The nature of this form of bidding limits information in sealed bidding and increases the complexity of analyzing data for IOCs during open bid auctions. In simultaneous sealed bid auctions IOCs bid on multiple licenses simultaneously, and consequently, receive no information about evaluations from other IOCs until the winners are announced. This type of auction provides valuable information for the state on how IOCs value different blocs, as bidding in sealed auctions closely reflects market evaluations (Cramton, 2007, p.123-4). There is also a possibility that companies win more blocs than they can afford or have the physical capital to exploit resulting in defaults (Sunnevag, 2000, p.9). This could be detrimental to state goals pertaining to development plans or future revenue streams, and could also play into IOCs strategies resulting in them discounting their bids, lowering overall revenue for the state.

In simultaneous open bid auctions states must consider the increased possibility of collusion. In simultaneous sealed bid auctions it is easier for an IOC to defect on its conspirers, while in a simultaneous open bid all the information is instantly available, ensuring everyone plays their role in the scheme (Cramton, 2007, p.134). This could result in less revenue for the state and prevent other companies from entering the industry. Goeree *et al* (2006, p.556) also found that in simultaneous open bid auctions the state may receive less revenue than sealed bid auctions because strong players can "trail" weaker players until the weaker player can no longer increase its bidding, leaving the stronger player to win each bloc by one bid increment. On the other hand, Sherstyuk*et al*, (2006, p.3) state if the designers top priority is the efficient allocation of licenses, then using simultaneous open (ascending) auctions is the best auction system.

Sequential sealed auctions have many of the same benefits and faults as simultaneous sealed auctions. The main difference is that the information the state receives will be less reliable as the auction progresses because IOCs will adjust their bidding strategies based on the results they receive from each successive bloc being auctioned (Goeree *et al*, 2006). Sequential auctions, either sealed or open, were also found to result in more frequent occasions of collusion among participants because of the ability to have "explicit communication" among bidders after each successive auction (Sherstyuk *et al*, 2006). Goeree *et al* (2006, p. 573) concluded that if revenue were the number one goal, then a sequential sealed auction where the most valued licenses are sold first would produce the highest returns. In sequential auctions the state must decide in what order the licenses will

be sold. Depending on the order blocs are auctioned, IOCs will employ different strategies that could directly correlate into the amount of revenue the state is likely to receive.

Sequential open auctions are also very similar to its counter part, simultaneous open auctions. In this instance, each license goes through a separate open auction in a successive format one after the other. This form of auctioning opens up the greatest opportunity for collusion because of its open format, where players receive the most information about each other'sbids. As compared to the simultaneous open auction, the sequential auction works best in competitive environments. Because of its sequential nature, it is easier for players to develop strategies and digest the information being provided rather than trying to analyze all the information instantaneously during a simultaneous open auction.

Summary of State Preferences in Auction Systems

The design of auction systems for E&P leases reflects the preferences of state actors. The sequential sealed auction's most prominent feature is its ability to raise revenue for the state. This hinges on state actors ability to successfully rank the blocs from highest to lowest value. This auction system also ranks second highest with regards to providing information about the blocs to the state because IOCs are forced to submit bids that reflect market evaluations of the blocs. The sequential sealed auction also has some downsides. It is the second most susceptible auction system for collusion and ranks third

in efficiently allocating licenses. It would also be considered by IOCs to have low transparency.

Sequential open auctions most prominent feature is its susceptibility to collusion. This auction system ranked first among the four analyzed. It also provides less information to the state than the sequential sealed or the simultaneous sealed auctions. The positives of this auction include its high transparency for IOCs and the fact it allocates licenses second most efficiently behind the simultaneous open auction. This auction system works best in competitive environments because of its open auction nature that allows aggressive bidding to drive up the price.

Simultaneous sealed auctions most prominent feature is its ability to provide information to the state. The simultaneous and sealed nature of the bidding process results in bids closely reflecting market evaluations, giving the state a fair approximation of its resources value. On the negative side, because it allocates licenses the least efficiently, there is a high potential for IOCs to default on their blocs that could result in costly renegotiations and delays in rent extraction. This auction system is ranked third most susceptible to collusion and also presents low transparency for IOCs.

Simultaneous open auctions most prominent feature is its ability to efficiently allocate licenses. Because of its open and simultaneous bidding process IOCs are more likely to win the licenses they value the most. It has high transparency levels and is the least susceptible auction to collusion; however, it does not provide state officials with reliable

information pertaining to the value of the resource nor does it work well in low competitive environments. Similar to the sequential open auction, this auction design only raises revenue well in highly competitive environments. A summary of state preferences and linkages of auction systems is provided in Diagram 2.

Diagram 2: State Preferences in Auction Designs					
Auction	Preferences				
Design					
	Efficiency	Revenue	Collusion	Transparency	Information
Sequential	3 rd in	1st for	2 nd most	Low	2^{nd} in
Sealed	allocating	revenue	susceptible	Transparency	providing
	licenses	potential	to	for IOCs	the state
	efficiently	(ranking	collusion		with
		blocs highest			information
		to lowest)			
Sequential	2^{na} in	$2^{na}/3^{ra}$ Works	1 st most	High	3 rd /4 th Less
Open	allocating	best in	susceptible	Transparency	information
	licenses	competitive	to	for IOCs	because of
	efficiently	environments	collusion		IOC
	the	th -	- *0	_	strategies
Simultaneous	$4^{\rm m}$ in	4 th Potential	3 rd most	Low	1 st in
Sealed	allocating	for high rates	susceptible	Transparency	providing
	licenses	of defaults	due to	for IOCs	the state
	efficiently;	and costly	time		with
	potential	renegotiations	constraints		information;
	for IOCs		and ability		companies
	to win		to punish		must submit
	more		players		based on moreleat
	those con		who defect		market
	afford or				prices
	explore				
Simultaneous	1^{st} in	2 nd /3 rd Works	1 th most	High	3 rd /4 th Less
Onen	allocating	the best in	susceptible	transparency	information
open	licenses	competitive	to	for IOCs	because of
	efficiently	environments	collusion		IOC
	j		because of		strategies
			difficulties		
			in co-		
			ordination		

Chapter 3: Case Study

Brazil and Venezuela serve as suitable case studies because of their geographic proximity, economic similarities, and emerging status as dominant world players in the oil and gas industry. Brazil and Venezuela have GDP per capita of \$12,000 and \$13,200, unemployment rates of 6.2% and 8%, and poverty rates of 21.4% and 31.6% respectively (World Factbook, 2012). Each of these countries produces similar amounts of crude oil on a daily basis, 2.63 million bbl/day in 2011 for Brazil and 2.47 million bbl/day in 2011 for Venezuela (ibid). Both states are dominated by state owned enterprises, Petrobras in Brazil and Petroleos de Venezuela SA (PDVSA) in Venezuela. Both states also have a long history of socialism and protectionism regarding their state resources, especially oil and gas. More recently, both states have uncovered huge new reserves such as the pre-salt basins of Brazil and theOrinoco Belt in Venezuela. The reserves in Venezuela are believed to be the largest on earth. Within this context both state's experienced long periods of protectionism from foreign investment until they decided to open up their petroleum industry to foreign investment and design auctions to allocate E&P licenses. The following case study will explore the evolvement of their petroleum industry to determine the goals and preferences that affected state actors decisions regarding auction design.

Brazil

The oil and gas industry in Brazil is characterized by the dominance of their state-owned company Petrobras. Its creation stems from a wave of nationalism that was sweeping the nation in the late 1940's and 50s(Smith, 1972). Led by its populist leader President

Getulio Vargas, Petrobras was a rejection of Brazil's colonial past and the capitalist ideology that its Portuguese colonizers had pushed towards the state (Ibid). Its creation in October of 1953 under Law No.2004, resulted in the state owned enterprise being given a monopoly over upstream exploration and production activities, but it also came to dominate downstream activities of refinement and distribution. (da Motta *et al*, 2008, p.6). By the early 1990's the nationalist pride that had dominated the creation and development of Petrobras had subsided. With the election of President Cardoso, he pushed for the privatization of multiple SOEs and the liberalization of previous monopolistic markets (Goldstein, 2010; Schmitz and Teixeira, 2008; da Motta et al, 2008). One of his main goals was for Brazil to be self-sufficient in the domestic production of oil,but to accomplish this goal he recognized the industry needed foreign investment and expertise, as well as, competition for Petrobras (da Motta *et al*, 2008, p.14).

The Brazilian oil and gas industry was liberalized in 1997 after forty-four years of protection. With the enactment of Law No. 9478 or the Petroleum Act, the oil and gas industry in Brazil opened up its boarders to foreign investment and competition. This piece of legislation reflects the policy goals of the state to encourage the growth of domestic production (Chapter 1:XI), to promote local content (Chapter 1:X), and to improve the competitiveness of Petrobras (Chapter 2). As will be discussed further in this case study, once these goals were achieved new legislation was passed in 2010 under Law No. 12,351 that restricted the industry once again. In both instances the auctioneering process for E&P licenses was the main tool utilized to achieve these goals.

To regulate and control the newly liberalized oil industry the Petroleum Act created the National Energy Policy Council (CNPE) and the National Petroleum Agency (ANP) (Mariano and La Rovere, 2007). The CNPE proposes policies and actions to the president while the ANP is tasked with "regulating, overseeing and contracting activities for the oil and gas industry" (ANP, 2010). One of its main duties is to oversee the auctioneering mechanism that distributes the E&P licenses. Previously, Petrobras had a monopoly over blocs of land that the state would release for E&P activities, but post 1997 it would have to compete during auctions. Section III of the Petroleum Act sets out the bidding process and requirements while ANP enforces the regulations. The auctioneering process can be categorized as a multi-license first price sealed auction. In other words, it is a sequential sealed auction with package bids (packages usually containing licenses for complimentary blocs) (ANP, 2009). IOCs competing for licenses place bids that contain signature bonuses, local content requirements, and work programs. The bids are evaluated by a "Bidding Special Committee" under the ANP who choose the winner based on each criterion representing 40%, 20%, and 40% respectively of their final score (Ibid).

Based on the articles produced and the legislation pertaining to the liberalization of the industry, state preferences reflected a desire to expand domestic production, to promote domestic content, and to increase competition in the industry. The auction design addressed all of these goals separately. The very introduction of the auction process in 1997 began to stir competition in Brazil's oil and gas industry. To expand production in

Brazil, Petrobras and IOCs would have to discover new oil fields and this could only be achieved through additional exploration. The 'work program' component of the bid sufficed this goal, as well as, the 'signature bonus' component promoted pre-bidding exploration in order for companies to try and determine the potential value of blocs up for auction. These two components represented 80% of the criteria for measuring the value of a bid. In addition, the state wanted to spur the development of the domestic oil and gas service industry, which it did through the domestic content requirements in the bidding process. The range of goals that state's could address in the bidding process is endless, meaning understanding state preferences is important to anticipate what demands the state will try to incorporate in the bids.

The auction process can also be linked to the state's goals of Brazil. Information would arguably be the most important criteria in choosing an auction process because this helps the state determine where the most valuable fields are located and how much they are worth. This is important to recognize when we discuss changes to the auction process in 2010. Drawing on 'Diagram 2' the best auction process to determine 'information' is the 'simultaneous sealed' auction; however, Brazil chose the sequential sealed auction, which is the second best auction process for 'information.' This choice can be explained by comparing these two auction processes. When evaluating the simultaneous sealed auctionit has two major weaknesses; it is ranked last in efficiency and in raising revenue. On the other hand, sequential sealedauctions ranks first in raising revenue and third in efficiency (one place above simultaneous sealed). When it comes to transparency, both are ranked low and with regards to collusion they are ranked in the middle of the pack;

therefore, the sequential sealed option links closest with state goals, especially when considering what is contained in the bid itself.

The liberalization of the oil and gas industry, in conjunction with the auctioneering process, resulted in an explosion of exploration and development in Brazil. During the period between 1998 and 2010 proven reserves doubled from 7.1 billion barrels to 14.2 billion barrels and daily oil production went from 1 million bpd to 2.13 million bpd (ANP, 2013). The estimated reserves continued to rise dramatically as more exploration occurred in the pre-salt area where potential reserves had climbed to 70-100 billion barrels of oil and natural gas (Brazil Government, 2013). Hernandez-Perez argues that these large discoveries prompted the state to re-design their auctioneering system into a new framework for the pre-salt area (Ibid).

Less than a decade after liberalizing its oil and gas industry, Brazil became self-sufficient in the production of crude oil in 2006 (OECD/IEA, 2006, p.3). By 2009, the state had begun to re-design their auctioning system because oil companies had by this time found significant new reserves that could sustain Brazil's growth and self-sufficiency into the perceivable future (Hernandez-Perez, 2011, p.64). The goal of self-sufficiency was already partially protected in the original 1997 legislation as companies operating in Brazil would be obligated to sell their oil to the domestic market in case of an oil shortage (da Motta *et al*, 2008, p.70). In 2010, under Law No.12,351 the state changed the auctioning system for the pre-salt area (where the new major reserves were located) and for any future area the state determined to be 'strategic.' In the new auction design, the process would still be the same, sequential sealed, but instead of submitting bids with signature bonuses, domestic content requirements, and work program components, the bid would only contain a production sharing contract (PSC) component. The winning bidder would provide the state with the highest percentage of total production in the form of physical barrels of oil. In addition, Petrobras would automatically receive a minimum 30% stake and be the sole operator over the oil field (Brazil Government, 2013a). This auction process reflects the state's goal of increasing domestic production. It also ensures that Petrobras, their state owned enterprise, continues to dominate the Brazilian oil and gas industry. This ensures the state has an additional tool to achieve any of its future goals or preferences.

Venezuela

The oil and gas industry in Venezuela, like Brazil, is dominated by state owned enterprises. During the first half of the 20th century the Venezuelan government slowly embarked on a path towards state control of its natural resources. The process unfolded over a half century of gradually increasing royalty rates for private companies in the natural resource sector (Wiseman and Beland, 2010). By 1975, the government created Petroleos de Venezuela, S.A. (PDVSA) through legislation called the *Organic Law that Reserves the Industry and Commerce in Hydrocarbons to the State* (PDVSA, 2013). The following year in 1976, under the legislation *Ley de Nacionalization del Petroleo* Petroleum Nationalization Law, ownership of all private companies operating in the oil and gas industry were nationalized and placed under the control of PDVSA (Wiseman andBeland, 2010, p.143). The overwhelming dependence of state revenues on the

performance of the oil industry resulted in the state making special accommodations for employees of nationalized companies. To try and preserve the private sector culture and mentality into the newly created PDVSA, state officials agreed to not interfere with "managerial autonomy" and allow managers to make decisions based on the free market (Philip, 1999, p.366). However, from the beginning state goals related to OPEC contradicted the goals of PDVSA's officials, especially regarding production levels and export quotas (Ibid). During the early 1980s the price of oil had dropped dramatically, prompting PDVSA officials to increase production. This decision was constrained by state officials who wished to maintain production levels set by OPEC. This paradox inevitably created tensions between the policy goals set by the state and PDVSA.

The 1990's marked the beginning of a brief period of increased independence for PDVSA. With the appointment of Luis Giustias President of PDVSAhe embarked on a movement of *Aperture* or opening up of the oil industry (Wiseman and Beland, 2010, p.144). During this period the state reduced the amount of royalties it extracted from PDVSA, which allowed the company to expand and invest abroad. *Aperture* also marked the allowance of foreign capital back to Venezuela. This period aligned both state and PDVSA goals. As Philip (1999, p.374) states, many citizens were worried that PDVSA was becoming too powerful. For instance, at one point the state owned enterprise had over 150 economists on the payroll who were directly advising the government over issues inside and outside the oil industry (Ibid). Wiseman and Beland (2010, p.145) reveal that managers from PDVSA were even transferred into high-level positions within the Ministry of Energy and Mines to ensure state policies were consistent with its own.

During their research Wiseman and Beland, through interviews of former PDVSA managers, uncovered that the primary goal of PDVSA was not to be sheltered or protected by the state but to liberalize the entire industry because it felt it could compete domestically and internationally with the largest companies of the world (2010, p.149).

The culmination of the *Aperture* movement occurred in January of 1996 when the first auctions open to foreign investment were conducted. These auctions were the first to take place since the creation of PDVSA in 1976 (Oil and Gas Journal, 1996). It was a difficult struggle to convince the Venezuelan congress to allow foreign direct investment and it came with stringent terms that were much harsher than most other foreign oil regimes (Engen, 1997). Yet, private investment was crucial if PDVSA wanted to meet its primary goal of increasing production (BloombergBusinessweek, 1996; Oil and Gas Journal, 1996; 1997). Its target was to increase daily production from 2.9 to 6.1 million barrels in anticipation for an increase in world demand (Ibid). As Giusti (1999), a former CEO of PDVSA explains, the political elite and general public were very wary of private interests influencing the operations of their state owned enterprise; however, managers at the company recognized that the development of the huge Orinoco basin hinged on foreign investment and technology.

The 1996 auction took place using a sequential sealed bid process that had foreign investors compete using signature bonuses and profit sharing agreements (Engen, 1997). The participants of the auction were chosen by PDVSA and following exploration activities of winning bids they could exercise an equity stake option of up to 35% (Ibid).

The design of the bidding component reflects the struggle between the goals of PDVSA and the concerns of the state over private companies developing its oil resources. In the case of Venezuela, the geological risk was very low as proven reserves were generally regarded as some of the largest in the world (OPEC, 2013). This immediately reduces the possibility of a work program component. This is likely the reason the state used only a signature bonus and profit sharing arrangement in the bidding process. The effectiveness of this arrangement is questionable. If PDVSA's preferences were the sole force behind the bid make-up then its possible a pure work-program component might have been feasible because of the optional 35% equity stake that could be implemented once production was ready to occur. This would of led to big increases in daily production rates as larger tracts of land were explored and readied for production. However, the current form with the signature bonus and the profit sharing component reflects the state's goal to try and extract as much rent as possible. Engen (1997) estimates that based on PDVSA's share, royalties, and income taxes foreign companies would only receive 10% of the profits by the end of the investment, instead of the international average of 20%.

The auction process used in 1996 was a sequential sealed bid auction. This process reflects the state's willingness to use the process to extract rent as it ranks first out of the four auction designs discussed. The state's primary goal was to ensure they extracted the maximum amount of rent out of foreign firms coming to Venezuela. It also reflects the image the state wanted to portray to its people who were sceptical about having foreign firms operating in their country. In order for PDVSA to succeed in promoting foreign

investment they had to accept the preferences and goals of the state in the auction design. Like in the Brazilian case, the sequential sealed auction provides the second most information, the third in efficiency, is second most likely to result in collusion, and has low transparency measures. It may be futile to postulate what auction design would have occurred if PDVSA's preferences were the sole concern, but its conceivable a simultaneous open auction would have worked best as it ranks first in efficiently allocating licenses. This is especially true in the Venezuelan context as the value and geological risk of the resource was known.

After this initial auction in 1996 there were only a few more auctions until President Hugo Chavez was elected in 1998 ending the *Aperture* period. From 1998 to 2008 there were no auctions and foreign companies were discouraged from operating in the Venezuelan oil industry (Petroleum World, 2010). During this period President Chavez extracted billions of dollars from PDVSA, eventually taking direct control over the company in 2003. This takeover resulted in over half its workers being fired and replaced by supporters of the Chavez regime (Oil and Gas Journal, 2003). In addition, the state expropriated assets from foreign investors who refused to give majority ownership to PDVSA (Carlos, 2011). This tumultuous period not only resulted in the state not meeting its goal of doubling production but actually resulted in an overall decline of oil production per day. (Index Mundi, 2013). With the state controllingPDVSAits production declined, new investments were stymied, and cash reserves were depleted. These circumstances resulted in the state shifting its goals and preferences, and consequently, designing a new auction system in 2008.

President Chavez opened up the oil industry in 2008 to foreign investment because PDVSA did not have the financial or technological capability to exploit the mass oil reserves in the Orinoco oil belt. The mismanagement of the state owned enterprise by the Chavez administration resulted in the auction design being heavily skewed towards private investors with regards to financial risk. The auction process stayed the same as before, sequential sealed, but the bid component was restricted to simply a signature bonus. However, the winning bids were automatically obligated to give PDVSA a 60% ownership (Carlos, 2011, p.4) In addition, the foreign company would have to provide 100% of the investment, be taxed at 50%, pay a 33% royalty and would be unable to avail of international arbitration tribunals in case of an investment dispute (Ibid). In this instance the auction process was simply a mechanism to choose a winner based on providing the biggest upfront signature bonus. The winners of auctions were also required to sign agreements stating they would achieve oil production of 400,000 barrels per day within specific time periods (Watkins, 2010). This reflects the state's goal of increasing production and exploiting its large oil reserves.

Conclusion

The aim of this thesis was to identify and link policy goals and preferences of state actors to specific auction designs for the allocation of E&P licenses. Using the theory of Rational Choice Institutionalism to guide its analysis, this thesis focused on the preferences of state actors, the design of auction systems, and the behaviour of IOCs. The literature review outlined the various forms of rent used in auction bids such as signature bonuses, work programs, profit/production contracts, and royalty rates. It then outlined policy goals and preferences to each form of rent based on the anticipated behaviour of IOCs. This same process was then used to analyze auction designs including sequential sealed, sequential open, simultaneous sealed, and simultaneous open. The benefits and disadvantages of the various rent forms and auction designs were summarized in Diagram 1 and 2 respectively.

Using the literature review that was collected under the auspices of RCI, the thesis attempted to link the preferences of state actors to specific rent forms and auction designs, and then test these in the two case studies of Brazil and Venezuela. The results of this experiment were mixed. The analysis of rent forms and auction designs on IOC behaviour contributed to the ability to make linkages between policy goals and preferences of state actors to auction designs; however, the ability to use this information to predict beyond the 'basic' auction design is unclear at this point. State goals and policy preferences can become very complex and because of the versatile nature of auctions a large proportion of these goals and preferences could be reflected in its design. This

thesis provided a foundation of the most basic rent forms and auction designs but more research is required in the future to progress in this field.

The most prominent limitation of this thesis was the methodology used within the case studies to link state actors policy goals and preferences to auction design. This article relied upon legislation, academic journals, and petroleum industry media to draw linkages; however, there was a limited amount of literature pertaining to this topic and in many cases it was unclear if the article was referring to a specific state actor or the state in general when referring to auction design. In future research, using methods such as process tracing to focus on specific state actors may result in clearer results that link actors goals and preferences to how they designed their auction system. This process would entail detailed interviews with actors involved in the design process and an overview of internal government records, particularly of meetings. The time period to conduct this sort of analysis, and the ability to communicate in Portuguese and Spanish was outside of the author's ability for this thesis.

Outside of these limitations, the value of this research can make a meaningful contribution to the understanding of state designs of oil and gas auctions. As the importance of oil and gas resources only continues to increase the importance of this topic will as well. As new fields become more difficult to find and competition increases, the auction process will inevitably become more important.

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