An Overview of Brazilian Petroleum Exploration Lease Auctions

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Abstract

The concession process for oil and gas exploration through competitive bidding marks a significant step for Brazil's petroleum sector after 1997, which created an attractive setting for oil industry investments. Its geological potential, as proven by the results achieved through the discovery of giant oilfields, stimulated oil companies to participate in auctions hosted by the Brazilian National Petroleum Agency. Using a classical competitive first-price sealed bid model, this process grants companies the rights to exploration under a concession contract signed with the government's representative. A number of eight licensing rounds, performed yearly, guaranteed about 443,840 km^2 of exploration area for 141 oil companies who spent over R$ 3.84 billions as bonuses, which could be considered as a indicator of the success of the Brazilian bidding process. This paper presents an overview of the main aspects and results of Brazilian petroleum exploration bidding which is a specific experience of change from a monopoly to an open market entry for E&P investments. A review of exploration activities before the opening of the petroleum sector is also included to explain the impacts creating by the new market settings.

Keywords *Petroleum exploration, auctions, risk.*

Introduction

Until 1997, upstream activities in Brazil had been conducted exclusively by a state-owned company, PETROBRAS[1], when Petroleum Law 9.478/97 was approved, ending a 42-year monopoly of oil and gas exploration and production. Since 1998, the Brazilian petroleum regulatory agency has been hosting yearly licensing rounds for leasing acreage for petroleum exploration rights under a concession regime. The adopted model is competitive sealed bid auctions, in which the winner is the oil company presenting not only a higher cash bonus, but also committing an expressive exploration program and a percentage of local content in services and operations to be applied in both the exploratory and production development phases.

The bidding scheme favors government's expectation to maximize the chances of a fair market value for the right to drill for and to produce oil and gas on public lands. In an oil and gas lease setting, auctions can serve as an allocation mechanism and as resource rent taxation. An auction provides the

1 Petrobras ownership has a significant participation of the private sector (ADR, Bovespa). The government holds approximately 32.2% of the capital and BNDES 7.6%.

government both with better information about a company's perception of the value of a resource tract and with the potential of considerable higher future revenues from its licensing.

Campos Basin outcomes push the oil companies to heavily invest in Brazil through the acquisition of exploration rights since the first licensing round, believing that Brazil is the new "Eldorado" for petroleum exploration discoveries (Moraes Jr. et al., 2004). The oil and gas production of Campos Basin presently corresponds to over 80% of Brazilian domestic production that recently reached 1.8 million bbl/d, making the country self-sufficient in domestic oil supply.

Oil companies are also envisaging a promising new frontier known as the "pre-salt play" recently drilled in deep water Santos Basin. Their enthusiasm for the geological potential for hydrocarbon generation and for finding giant oil and gas fields in this setting lead the companies to compete strongly in the last licensing round, increasing the cash bonus value of the areas to figures never seen before in Brazilian rounds. Since 1999, eight licensing rounds have been held in Brazil, in which more than 3,000 blocks[2] were released and over 140 oil companies spent approximately R$3.8 billion.

The goal of this paper is to give an overview of the whole process of Brazilian auctions including their modeling aspects, strategies and results, in addition to a review of exploration activities before the opening of the petroleum sector.

This paper is organized in two main sections: The Opening of the Brazilian Petroleum Sector and Petroleum Auctions Rules and Strategies. In the first part subjects such as the monopoly period, the Brazilian geological setting and the role of the Brazilian National Petroleum Agency will be addressed. In the second part the Brazilian bidding process, strategies, rules and results as well as the dynamic of competing or cooperating in bidding systems will be presented. The final section presents general remarks and conclusions.

The Opening of the Brazilian Petroleum Sector

For over 40 years, PETROBRAS had the rights and obligations to carry out petroleum exploration, production and marketing under the aegis of the petroleum state monopoly.

The Brazilian Constitution of 1934 and 1937 defined that all mineral resources belong to the state and any exploration of natural resources should take place through a concession regime law. A Mining Code was enacted in 1934, formally defining the state monopoly of petroleum. Regulatory agencies such as Conselho Nacional do Petróleo (CNP) and Departamento Nacional de Combustíveis (DNC) were created to regulate and to conduct all related activities (Ribeiro, 2005). In 1953, PETROBRAS was created as a state-owned company, and remained so until to 1995, when constitutional amendment 09/95 established the end of the petroleum monopoly held by PETROBRAS. Two years later, Petroleum Law 9.478/97 established the main principles and guidelines of national energy policy, creating both the Agência Nacional de Petróleo, Gás Natural e Biocombustíveis (ANP) and the Conselho Nacional de Política Energética (CNPE) as reported in Bucheb (2007).

The Monopoly Period

The boom of the oil industry around the world motivated the start of petroleum activities in Brazil. After the Second World War, the imbalance between demand and supply of oil products enhanced progressively, stimulating countries to perform more activities to find petroleum resources in their own territories to avoid an increasing dependence on fuel or crude oil imports.

At that time, there were two opposite development views in Brazilian energy and political scenarios. The country has a business sector with powerful international economic groups interested in both the refining and distribution sectors of the oil industry, as well as a strong nationalistic appeal derived from the popular historical campaign - "O Petróleo é Nosso" – seeking to guarantee the country's oil supply.

Arguments against the nationalistic movement were the uncertainties related to the existence of an active petroleum system in Brazilian sedimentary basins, and the limited domestic technological capability for petroleum exploration and production. Arguments in favor were the high level of credibility of the Conselho Nacional do Petróleo – CNP – and its strong political influence.

2 In Brazilian licensing rounds, the term blocks has the same meaning as area used traditionally elsewhere.

Created in 1938 by Decree 395/38, CNP played the role of an embryonic regulatory agency auditing and giving permits for petroleum exploration activities up to 1990, when it was closed. Two events should be highlighted during CNP management: the first oil deposit discovered in Lobato city (Bahia), in 1939, and the first commercial oil pool – the Candeias Field – with 350 MM bbl of oil in place, discovered in 1941 at Recôncavo Baiano Basin, which is still productive today. During this period, the Brazilian government decided, in 1953, to create a national oil company with Law 2004 – PETROBRAS – which would be in charge of the entire process of finding, producing and marketing oil and gas resources. In 1954, CNP transferred all its legacy of onshore oil deposits as well as its recognized technical consulting team to PETROBRAS (Mendonça et al., 2004).

PETROBRAS also inherited from CNP a 15 MM bbl reserve, a daily production of 2,700 bbl, and a goal to supply the challenging target of 137,000 bbl/d national demand. In 1960, CNP was incorporated into The Mining and Energy Ministery (MME), when the domestic daily production reached 43,300 bbl/d, but consumption bypassed 200,000 bbl/d. The first oil crises broke out in 1973 (the OPEC Embargo), raising oil price from US$ 2/bbl to US$ 14/bbl, when Brazil's 170,000.00 bbl/d oil production was coming from three different sedimentary basins: Recôncavo Baiano, Sergipe-Alagoas and Espírito Santo. The second oil shock (Iranian Revolution and Iran – Iraq War) blew up six years later when oil prices reached up to US$ 85/bbl. That year, 1979, the growing demand for oil was 1,133,000 bbl/d - pushed the government to establish an oil production goal of 500,000 bbl/d to be reached by 1985[3]. During this period, the federal government decided to implement a national program to produce ethanol from sugarcane as a gasoline substitute. This decision was motivated by the extreme burden placed on the nation's external trade balance by high oil import prices and was aimed at reducing petroleum imports despite the fact that the program required substantial additional investments and high subsidies (Moreira and Esparta, 2006).

When the petroleum state monopoly carried out by PETROBRAS ended in 1995, the oil price was US$ 17/bbl, oil production was 807,000 bbl/d and oil consumption was 1,498,000 bbl/d, but the anticipated self-sufficiency[4] in oil supply came only by the end of 2005. At that point, PETROBRAS was producing over 90% of the 1,800,000 bbl/d consumption in a scenario of high oil prices (US$54/bbl) forecasting continuous price volatility. Figure 1 presents the evolution of Brazilian oil production in million barrels, from 1950 to the present, and the petroleum price ($brent/bbl).

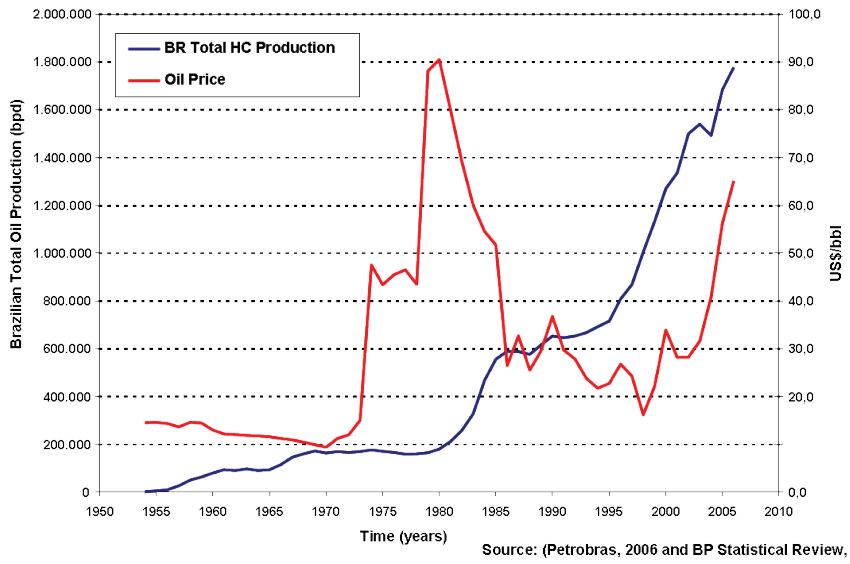


Figure 1 – The evolution of oil prices per barrel (actual values) and PETROBRAS petroleum production from 1950 to 2006. Oil prices reported are: 1861-1944 US Average, 1945-1983 Arabian Light posted at Ras Tanura, and from 1984-2005 Brent dated

3 All figures related to oil prices, oil production and consumption were obtained from *Platts* and Statistical Review Full Report Workbook, 2006.

4 The scenario of full self-sufficiency adopted by the government was equilibrium of 3 or more consecutive months between supply and demand during one year. In 2005, the country's total oil production accounted for self-sufficiency. In 2006, PETROBRAS reached oil self-sufficiency, with about 70% of its production coming from deep and ultradeep waters (Petrobras, 2006).

The Brazilian Geological Setting Attracted New Players

In addition to the successful results of Recôncavo Baiano Basin, by the end of 1960 PETROBRAS' exploration manager (Walter Link) reported that if PETROBRAS would like to stay in the petroleum exploration activities in a position to compete in the international oil scene, it should direct its attention to foreign countries as analogs in which the chances of finding oil and gas deposits were better than in Brazil (Campos, 2001).

In 1961, the PETROBRAS team indicated different techniques and models to evaluate Brazilian sedimentary basins. The results achieved through this approach proved that Brazil had a strong potential for petroleum with important oilfield discoveries such as Carmópolis (1.15 billion bbl of oil in place in the Sergipe-Alagoas onshore basin) and Miranga (600 MM bbl of oil in place in the Recôncavo basin).

Seismic acquisition and aeromagnetic surveys were performed in the Brazilian Continental Shelf at the beginning of the 60's at the same time as some advances in petroleum exploration technologies became available. In the early 70's, more than 53 wells were drilled in basins such as Foz do Amazonas, Potiguar, Campos and Santos offshore and Espírito Santo onshore basins.

Garoupa Field, an offshore oil deposit discovered in 1974, was the first expressive commercial find in shallow water Campos basin, the play drilled was Albian carbonates structured as a roll-over due to the fault system generated as consequence of the movement of Aptian salt domes. Following this trend of high-energy carbonates, a number of oilfields were mapped and discovered. Tertiary sandstone oil reservoirs were found as a secondary exploration target at water depths lower than 400 m (Mendonça et al., 2004). Other relevant plays in shallow water Campos basin were the Upper Cretaceous sandstones and the Lacustrine limestones of the rift sequence.

In 1976, exploration activities on the continental shelf of the Brazilian Equatorial Coast uncovered some Cretaceous oilfields with moderate volumes in both Potiguar and Ceará basin. The onshore portion of Espírito Santo basin had impressive results with oil production at 2,500 bbl/d from sandstone Eocene turbidites. Notwithstanding, Potiguar, Sergipe-Alagoas and Recôncavo basins also had good results for both oil and gas prospecting.

Extensive interpretation work focused on geological and seismic amplitude anomaly modeling revealed favorable reservoirs with good permeability and porosity and features such as bright spots – a gas sandstone pool - leading to the discovery of Piranema gas field located in the Amazon Cone.

Paraná Paleozoic basin was a very poorly sampled basin due to the existence of basaltic sills close to the surface and intruding low velocity layers. These sills interfere with seismic acquisition, generating noise and low resolution, and are hard to interpret in addition to having higher drilling costs. But, after some gas finds and considering the strategic location of Paraná basin in the heart of the southeast consumer market, the exploration work continued up to the discovery in 1997 of Barra Bonita Field, a 17 km^2 commercial gas accumulation (Campos et al., 1998).

By the end of the 70's, PETROBRAS had taken a 3D seismic capture of Campos basin, improving the quality of the geophysical data. Using seismic amplitudes and sequence stratigraphy concepts as direct hydrocarbon identification (DHI), the PETROBRAS team devoted attention to the sediment package deposited over the continental shelf by-pass zones. At the beginning of the 80's, all of the fields found in Campos basin proved the existence of an active petroleum system and the most prolific trend for petroleum exploration in Brazil. Oil reserves in 1983 were equivalent to 4 billion bbl and oil in place volume reached 30 billion boe.

Solimões basin, a Paleozoic basin, was drilled in this period with successful results for both gas (Juruá Field – Carboniferous sandstone) and high quality oil (Urucu Field – Devonian fluvial/eolic sandstone producing around 58,000 bbl/d).

In the middle of 1989, onshore Potiguar basin produced higher volumes of oil and gas compared to the mature basins of Recôncavo and Sergipe-Alagoas. Features such as those observed in carbonate reservoirs of shallow water Campos Basin were found in shallow water Santos Basin. The discoveries of high-energy carbonate fields filled with condensate opened a new frontier for this basin.

Although petroleum exploration in Brazil revealed a widespread variety of geological settings for oil and gas located around the country, what definitely attracted the attention of the international

oil industry were the deep-water Campos basin exploration results achieved in the 80's and 90's.

The advances in technology and its fast development for both seismic acquisition and drilling in water depths over 400 m allowed geoscientists to explore new offshore frontiers. Campos Basin, with its proven active petroleum system in shallow waters, was a natural candidate for the application of these technologies. In the 80s, in water depths over 400 m, a set of canyons dividing the platform were identified. A detailed investigation of this geological model lead to the discovery of the giant Marlim Field, a depositional fan system with 6 billion bbl of original oil in place. A series of tertiary turbidite sandstones were mapped in that decade, resulting in the discovery of other giant oilfields such as Albacora Field (4.5 billion bbl of oil in place) and Barracuda (2.7 billion bbl of oil in place). Information about general geological and geophysical features, reservoir characteristics, and development and production projects can be found in Assis et al. (1998) and Luchesi and Gontijo (1998).

In 1996, right before the opening of the petroleum sector to foreign oil companies, Roncador oilfield was discovered at a depth of approximately 1,500 m with 9 billion bbl of original oil in place. The evaluation wells drilled in Roncador lead PETROBRAS to a new record: the drilling in water depths over 1,800 m (Assayag, 1997). In 2001, for the second time, the Offshore Technology Conference (OTC), a recognized petroleum institution, awarded PETROBRAS a quality prize for its performance. As the offshore drilling technology reached 2,000 m water depth, new geological settings were mapped and a new giant oilfield (Jubarte Field) was discovered in the northern sector of Campos basin, opening a new perspective for exploration activities (Da Silva et al., 2004).

All these positive indicators push international oil companies to participate in Brazilian licensing rounds, and from 2000 to 2006, they made successful discoveries in Campos basin, with more than six economically successful oil deposits in this region, for example: Argonauta, Ostra, Abalone and Nautilus Oilfields (Shell / PETROBRAS / ExxonMobil); Polvo Field (Devon / SK); Papa Terra Field (PETROBRAS / ChevronTexaco / Nexen); and Chinook Oilfield (EnCana / Kerr McGee)[5].

The evolution of these discoveries, recorded by volumes of equivalent oil, can be seen in Figure 2 showing that technology and geological modeling improvements guide exploratory activities to results

5 The Consortium names presented in this paragraph reflect the name of the companies that were the concessionaire of the fields in year 2005. From year 2006 to 2007 ANP assigned the rights of Chinook Field to Anadarko and Hydro, Nexen withdrew from Papa Terra Field, and the assignment of Argonauta, Ostra, Abalone and Nautilus Oilfields from ExxonMobil to ONGC is still under analysis.

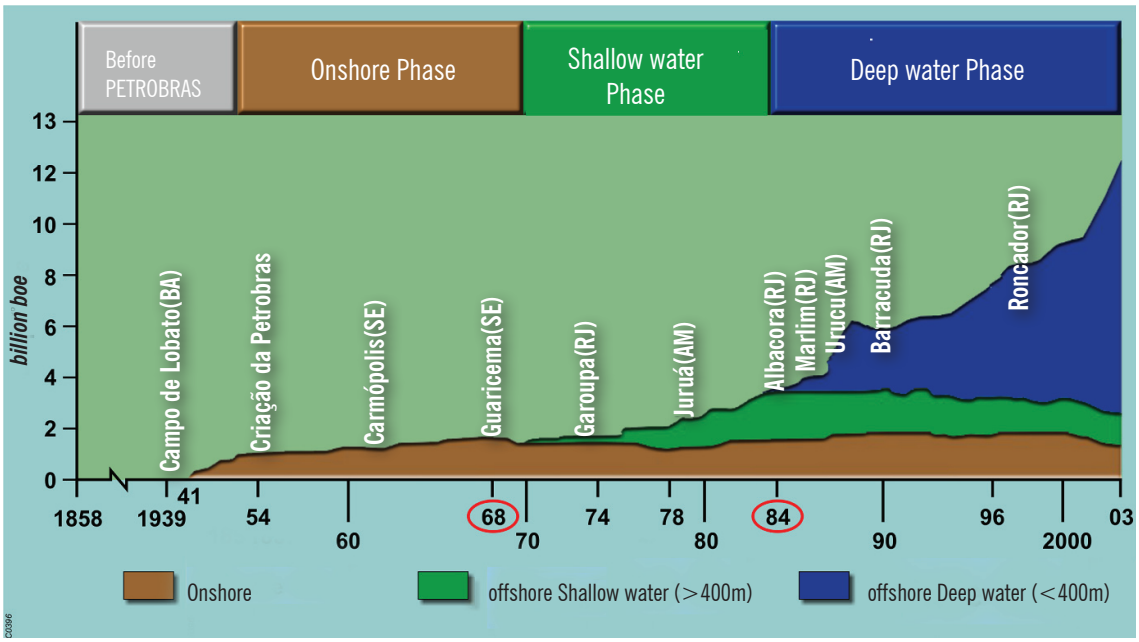


Figure 2 – The evolution of exploratory activities along the years and the resulting volumes of equivalent oil produced from onshore basins through deep water offshore basins

that range from 1.5 billion boe onshore volumes to a 12 billion boe deep water offshore reserves.

Recent exploration outcomes in deep water Santos Basin are creating the perspective of a new frontier, in terms of geological setting, that could revolutionize the exploration history of the country. In basins like Santos, which is prolific but mature, deeper and subtler opportunities should be pursued. Often these plays rely on new petroleum systems and/or preservation of deep porosity, as stated by Rudolph (2007). Oil companies are focusing their interest to pre-salt horizons located below a 2,000 m thick salt layer, which may enclose high volumes of hydrocarbon due to the size of the area mapped in the 3D seismic data. These perspectives stimulate PETROBRAS to pursue high risk/high reward potential plays in remote or challenging settings. Exploration in these frontier areas is being enabled by both a return to fundamentals and the next generation of basin concepts and modeling capabilities. Recent discoveries in such pre-salt structures confirm a new frontier for exploration and production activities. A competitive climate is driving up the cost of opportunity capture, creating a "winner's curse" scenario, as it is shown by the results of the unfinished Brazilian 8th auction.

The Role of the National Petroleum Agency

As previously discussed, Brazil's National Congress has created Petroleum Law 9.478/97 and two institutions: the regulatory agencies ANP and CNPE. These organizations report to the Mining and Energy Ministry and to the Government. Although ANP has important activities relating to auditing, contracting and regulating all segments related to petroleum economic activities, this paper concentrates more the role of ANP in promoting petroleum lease auctions.

One of ANP main targets is to define the rules allowing the set up and the maintenance of a competitive market that is beneficial for Brazilian economic development. Based upon the government taxation system created by the Petroleum Law and using the international petroleum price as a reference, ANP chose the auction process and designed a model for Brazilian acreage licensing rounds for the purpose of enhancing domestic oil and gas reserves and attracting national and international oil companies (ANP, 2007).

Before hosting the first licensing round, which required a selection of areas to be offered and preparation of a data package with technical information of those areas, ANP had to manage all existing geological and geophysical data acquired during the last 50 years as a result of the exploration and production activities carried out by PETROBRAS.

According with the new regulations established by Petroleum Law 9.478/97, for all existing oil and gas fields under production or in a development phase, PETROBRAS had a three-month deadline to submit a production development project for ANP approval in order to receive the concession rights.

Regarding all exploration activities in progress, and considering that Brazil has around 160,000 km2 of sedimentary basins (Fig. 3), PETROBRAS had to elect areas to keep exploring and others to return to ANP. In 1998, according to Article 33 of the Petroleum Law, PETROBRAS and ANP signed 397 concession contracts, with 115 exploration areas, 51 development areas and 231 production fields. This event is known as "Licensing Round Zero" (Furtado, 2004). Figure 3 shows that even after licensing acreage for eight consecutive years, ANP still has almost 97% of potential areas to be offered through auction, i.e., only 3% of total sedimentary covertures are under concession rights.

It is ANP's role to host the Brazilian licensing rounds. The announcement of a new auction in Brazil is made through a road show performed worldwide to attract companies' interest. ANP also develops all rules, contracts and procedures that companies should follow to participate in the leasing, as well as the minimum bonus for each area under offer and the selection of areas. The bidding model structured by ANP will be detailed in the next topics.

Auction dynamics and success depends on the number of participants interested in investing in the country. ANP adopted the practice of getting companies' feedback through public hearings, so the concession contract clauses and regulations could better reflect companies' international experience and expectations in petroleum exploration, production and commercialization in the Brazilian market. An important issue that motivates companies to keep investing in acreage acquisition is the assurance for companies to export the petroleum

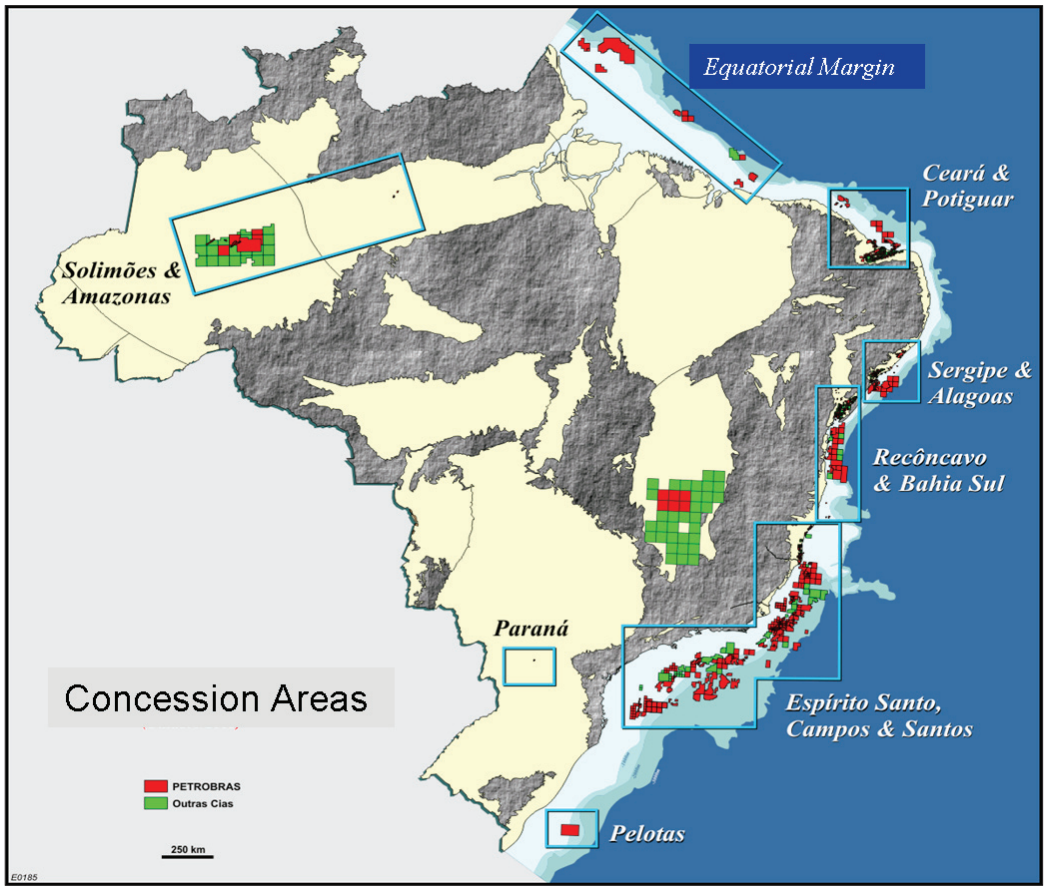


Figure 3 – Brazilian map showing all sedimentary basins in light yellow and the acreage under concession contracts since 1998. PETROBRAS' areas are the red blocks (solo or in joint ventures) and other companies' areas are green blocks (solo or in joint ventures)

produced[6] and the attractiveness of petroleum basins for giant oil and gas resources (ANP, 2007).

Since 1999, the regulatory agency has hosted eight licensing rounds. The eighth was interrupted and the ninth is scheduled for November, 2007.

What are the Rules and Strategies of a Petroleum Auction?

In order to exploit natural resources efficiently, government agencies can choose, among several approaches, a model to assign exploration rights for the companies that guarantee a performance in accordance with the best practices of the industry. Focusing on the petroleum industry, there are two main processes for allocating petroleum leases: informal, such as direct negotiation, and administrative, such as auctions.

The informal process has some constraints such as lack of transparency, specific preferences, corruption and its tendency to be more vulnerable to expropriation, which reduces both competition among the companies and government revenues.

On the other hand, an auction requires rules clearly established before the start-up process, giving transparency benefits for both bidders and auctioneers, mitigating potential corruption and encouraging competition through a fair process (Cramtom, 2005). The bidding process is a mechanism that has been widely used by different countries to distribute their oil exploration acreages optimally. The auctioneer is concerned with the long-term health and growth of his business, not with maximizing his expected revenue from a single auction. These are accomplished by balancing sellers (government) and buyers (companies) targets, i.e., it should have

6 The Petroleum Law states that only in a *force majeure scenario*, such as a strong disruption between supply and demand, are the companies temporarily obliged to sell the oil and gas in domestic market.

high enough prices to keep sellers consigning assets for sale and it should have low prices to keep bidders voluntarily attending in sufficient numbers (Rothkopf and Harstad, 1994).

Another characteristic of the auction model is that it discloses information: how valuable the bidders believe the lease to be, and which bidder values it most. This information isconsidered a competitive advantage, since the bidders do not know a priori the actual value of the oil blocks. Knowing your competitors and the likelihood of their bids carries equal importance when compared to a good estimation of the actual value of the block offered, avoiding participants bidding less of their estimated values, a normal practice considering uncertainties in valuation and covering their potential losses in case of exploration failure.

These features push ANP into an auction model. The Brazilian leasing mechanism elected by ANP to assign petroleum exploration rights is a common value auction based on a competitive first-price sealed bid method.

The Brazilian Bidding Process

A well-designed auction model should consider five main aspects: pre-qualification, guarantees, reservation prices, auction form and biddable factor, such as working program, royalty, profit share and cash bonus (Cramtom, 2005). ANP built the Brazilian bidding model considering some of these aspects.

The main bidding processes are the following (Figure. 4):

- Announcement – ANP announces a licensing round and releases the areas to be offered with a minimum cash bonus value per area (similar to a reservation price). The areas are selected according to government strategies for the country's development, such as improving exploration activities in new frontier basins or in a specific gas province etc.
- Qualification - companies are requested to prove technical, legal and financial assurance, as well as indicate their intention to be operator or non-operator for onshore, offshore shallow or offshore deep-water areas. This qualification step assures both ANP and potential partners that a skilled company is able to carry out all commitments required by the regulatory agency.
- Technical data package – companies receive a data package with geological and geophysical data from the sedimentary basins on offer they wish to bid for, after confirming participation by paying a fee. This data package contain information such as 2D and 3D seismic data, well logging registers, geochemical analyses, aeromagnetic and aero-gravimetric measurements, cuttings, maps, petrophysical analyses, thin section petrography, among others;
- Bidding offer according to established rules and schedules - companies' qualified are only able to present offers solo or in joint ventures for the areas for which they bought the data package. The winning proposal is the one that has higher points considering the total amount committed as bonus, working program and local content.
- Concession contract signature - executed between ANP and an affiliate or Brazilian company (solo or in consortium), requires a cash bonus payment and a bank guarantee letter to prove companies' financial capability to perform the working program committed in the offerings. It is valid for up to 27 years, in case the exploration area turns into a production field.

The biddable factors to define the winning proposal per area leased are: cash bonus, minimum exploration working program (PEM) and local content (CL).

- Cash bonus – means the sum of cash money companies offer to have the rights to explore the area. ANP defines a minimum bonus value and companies may bid as much as they wish. In general, the respective literature says that they bid around 30% of the expected monetary value (VME) estimated for the area, and may reach 100% or even more (Furtado and Suslick, 2003);

PEM – means the amount of exploration activities companies will carry out in the area. It is a commitment assumed by companies when presenting their offers and reflects how companies see the potential of the area. The more aggressive the PEM is, the higher the value of the area is for the bidder.

CL – the local content is a percentage of both the exploration phase and development and production phase. It is a commitment the companies assume to use national services and equipment envisioning the growth of Brazilian industry.

Historically the bidding processes have been updated to attend both government's and companies' expectations. There were four main modifica-

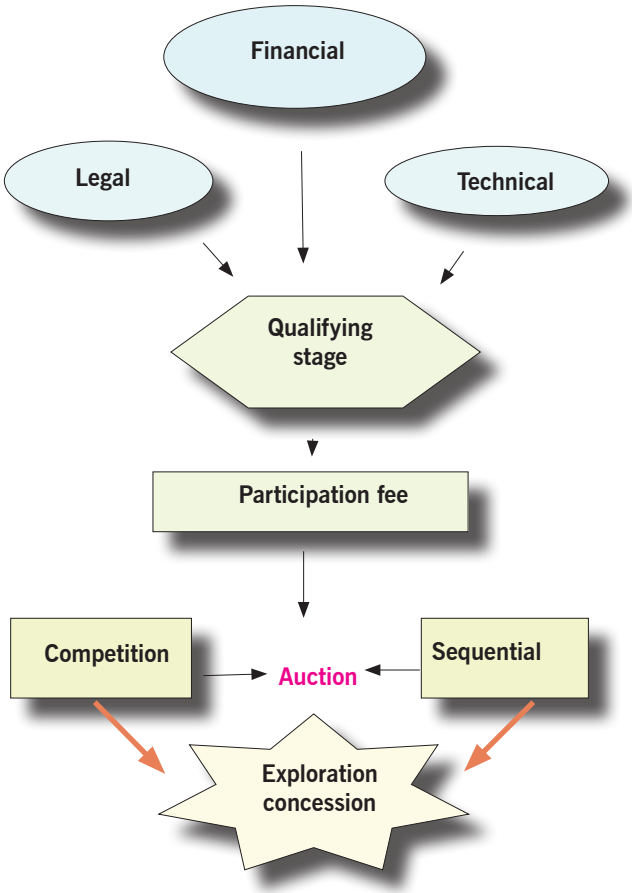


Figure 4 – Schematic of the main steps o the bidding process as modeled by ANP. The first step is the technical, financial and legal qualification stage, followed by the payment of a participation fee to bid in the sequential and competitive auction to become a concessionaire of an exploration area

tions introduced after the fifth licensing round: a) the auction itself, b) area size, c) PEM, and d) the formula to define the winning proposal.

The auction – the competitive first-price sealed bid was performed sequentially up to licensing round 4, becoming simultaneous after the fifth round. That means that the areas were being offered one by one in a previously known sequence.

Area size – from licensing rounds 1 to 4, the size of the areas released varied and their geographical coordinates were pre-defined by ANP. After the fifth licensing round, ANP applied a cell-model method defining a standard area size and creating the sector concept (distributed into onshore and offshore shallow, deep and ultra-deep water). Each area of a specific sector has, generally, the same size, except for areas that come from previous partial relinquishment by companies;

- PEM – from licensing round 1 to 4 ANP usually defined the value of the obligatory exploration program per area; it was not a biddable factor. After licensing round 5, companies were allowed to offer the value of the exploration program they wished to perform in the area of interest;

Winning proposal – before licensing round 5, cash bonus accounted for 80% of the formula to calculate the points and CL for 20%. Currently, the winning proposal is the one presenting a higher number of points summed from a weighted computation of the cash bonus, PEM and CL, according to equation 1. This new form creates an impact in the block assessment and disbursement committed in the auction process that will be detailed further.

$$\text{Winning proposal} = 40\% \text{ Bonus} + 40\% \text{ PEM} + 20\% \text{ CL} \quad \text{(Eq. 1)}$$

In Brazil, royalty is not a biddable factor being applied to areas under production with a fixed percentage, varying only if the fields are located onshore (5%) or offshore (10%). The fiscal system for petroleum production includes, in addition to royalties, a special participation tax (PE). This tax protects the government from underpayment by companies who discover large volumes of hydrocarbon. It has a progressive rate, varying from 10% to 40%, depending on the volume produced, the water depth, which the field is located, the net production revenue and the time of production. Area rental is also a fee paid by companies that increases as the area becomes more attractive and companies pass from exploration to development and production phases (ANP, 2007).

Competition and Cooperation in a Bidding Process

A primary advantage of an auction is its tendency to assign the areas to those companies best able to use them, which is accomplished by competition among bidders. Those companies with the highest estimates of value for the areas likely are willing to bid higher and hence tend to win the areas (Cramtom, 2005)

Assuming that all companies participating in a petroleum lease round are serious, have knowledge

of exploration and production activities, are qualified to participate in a specific tender and actually wish to acquire acreage according to their strategies and budgets, one of the divergence points among competitors may be the degree of information each company has.

Taking into account the uncertainties that exist in assessing an area to be leased, it is reasonable to consider that information has a fundamental role. If the information is available to all companies (public information), there is a symmetry among competitors. On the other hand, if some companies are performing exploration and production activities in the surrounding area, these companies will have more information than is publicly available (private information), spawning an asymmetry among bidders. Therefore, assessing a piece of information that is not public, a competitor is obtaining competitive advantage (Tavares, 2000). The information gives companies a better knowledge of the area's geological potential, allowing the decision to be made to participate in the lease and how aggressive the offer should be.

Iledare et al. (2004) stated that companies form a consortium with other likely bidders to pool resources or obtain the private information, and empirical data accumulated suggested a positive correlation between the numbers of joint ventures, bidders and bids. Tavares (op. cit.) emphasizes that companies combining expertise and technology reduce uncertainties and increase the value estimated for the area, possibly by decreasing the premium required to win the bid and discouraging small companies from competing. The referred author also concluded that generally, joint ventures are more aggressive and tend to win the auctions over companies bidding solo, however they usually left more money on the table. By definition, the difference between the amount of money the winner paid for the area and the second higher offer is called "money left on the table".

Usually the degree of competition in lease auction markets is evaluated by two attributes: the number of bids and the number of bidders per lease. Lohrenz (1991) observed that in any auction model, the government makes substantial gains in net expected values with more competitors, which are further incremented when bidding aggressively. Capen et al. (1971) noticed that the winner tends to be the bidder or consortium who overestimates reserve potential, which paid more for the area to avoid competitors, consequently suffering the winner's curse. Just for a quick review, the winner's curse is "successful bidders", at the time they win the game, which did not have an economic outcome in the exploration and production of the area leased.

The cooperation process, for a time, allows the homogeneity of technical and strategic companies' knowledge, promoting important learning in companies' behavior, improving competition analyses for future auctions.

The Brazilian Bidding Dynamic and Results

The first approach companies qualified had to participate in licensing rounds 1 to 4 was to build partnerships with PETROBRAS for reasons such as its unquestionable knowledge of Brazilian sedimentary basins and its possession of all available production flow systems. On the other hand, from PETROBRAS' point of view, the new rules and timetable imposed by the regulation directly affected its strategies to perform all related work to explore, evaluate and produce in the areas retained before the opening of the petroleum sector. The opportunity to share critical resources became attractive and the cooperative bidding strategy overcame the solo competition strategy (Fig. 5). Round 0 had a specific dynamic and reasons, previously presented in this paper, to achieve the results shown on Figure 5 as it may not be considered an effective auction related to the procedures adopted by ANP for leasing acreage.

Regarding the tactic companies have to approach each other to pool resources or share risks and information, leasing rounds 6 and 7 statistically show the same behavior as rounds 1 to 4, therefore the reasons behind the consortium strategy were clearly different from the one adopted for the first licensing rounds. An average of 27.5 % of partnerships engaging PETROBRAS is observed for both groups, rounds 1 – 4 and rounds 6 and 7 (Fig. 5). In these two mentioned rounds, companies were more confident in ANP rules, in the Brazilian fiscal system, and in the geological potential of the basins, considering the positive exploration results of some blocks acquired by companies in the prior rounds. Consequently, the strategy of forming joint ventures seemed to be more devoted to avoid competition or pooling investments due to scarce resources, than to share information. Increasing oil price scenarios stimulated companies to put large volumes of oil

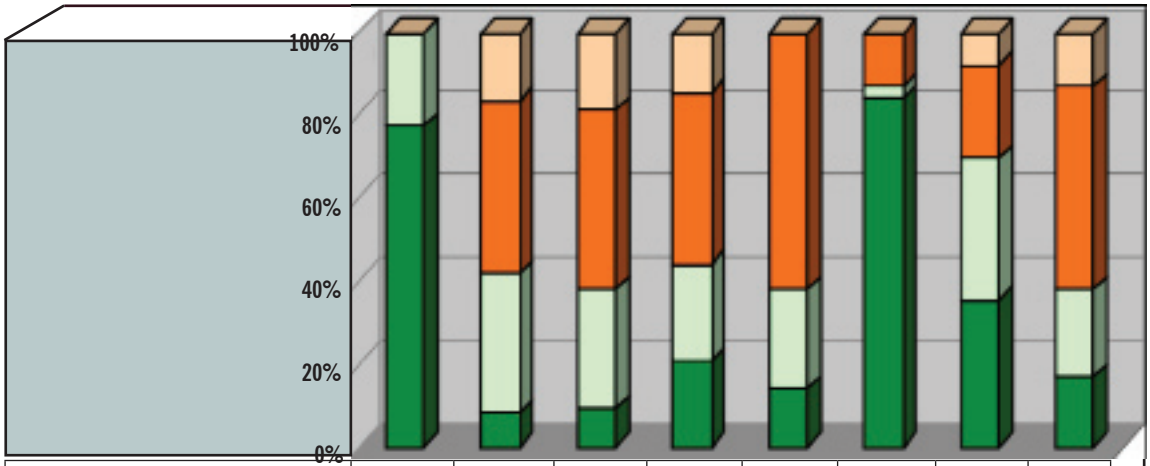
production on the market from the year 2005 on (Rodriguez et al., 2006). Partnerships were interesting because: (a) the increasing demand on limited resources (drilling rigs, FPSO etc.), which reached high daily rates in the oil market, pushing companies to pool capital, and (b) bidding as a consortium companies could enhance their chances to win the most valuable area of the auction, which could result in future reserve replacement.

Special attention should be dedicated to 2003, when ANP announced the fifth licensing round. Several changes occurred in the Brazilian fiscal system and in the regulatory scenario, directly affecting oil exploration and production as well as the bidding process. New bid rules and the unexpressive commercial results of blocks acquired in preceding leases led the companies to reduce their investments in the acquisition of new exploration areas in the fifth licensing round. This effect can be seen in Table 1, row ´Round 5´, in which there were just 12 companies qualified and only half of them presented offers. It is important to highlight that PETROBRAS itself acquired almost 90% of the acreage released in the fifth round (Figs. 5 and 6).

Table 1 gives an idea on the dynamic of companies' participation per licensing round in Brazil, varying significantly in numbers from the qualification process until the final offer. In general, 63% of the companies qualified did not actually present offers, an exception made for licensing round 6 which had 87.5% of the companies participating in the auction. Notice that round 8 was interrupted by ANP, meaning that all related data presented in this paper is partial and refers only to the blocks released until the bidding suspension. There is no concession contract signed between the winners and ANP for these blocks until December, 2007.

The signature bonus in Real currency and the area (km^2) per lease are presented in Table 1, however according to ANP regulations, is shouldn't be assumed that there is a direct correlation between the total amount of money paid as cash bonus and the total acreage acquired per lease.

Acreage acquisition depends on how companies deal with cash bonus, PEM and CL to present the best offer for a specific area of interest. As the formula to obtain the offer value considers weights for these variables (eq.1) there is a range of possibilities for companies to compose their bids. Furtado et al. (2008) present a methodology considering the use



	Round 0 (1998)	Round 1 (1999)	Round 2 (2000)	Round 3 (2001)	Round 4 (2002)	Round 5 (2003)	Round 6 (2004)	Round 7 (2005)
Companies´Partnerships	0	2	4	5	0	0	12	33
Companies´ Blocks	0	5	9	14	13	13	35	122
Petrobras´ Partnerships	26	4	6	8	5	3	52	54
Petrobras´ Blocks	89	1	2	7	3	85	55	42

Source: Moraes Jr et al. (2004)

Figure 5 – Brazilian licensing rounds 1 to 7: results for cooperation and competition strategies. Number of blocks acquired split into 4 categories: PETROBRAS bidding alone (dark green), PETROBRAS bidding in partnership (light green), companies bidding alone (dark orange) and companies bidding in partnership with companies other than PETROBRAS (light orange)

Table 1 – Number of oil companies qualified by ANP, presenting offers and the winners per licensing round in Brazil from 1999 to 2006, as well as the total amount paid as signature bonus and the total area acquired. Notice that Round 8 is a partial result as the leasing was suspended by ANP. *Source: Brazil Rounds (ANP, 2007)*

	Oil Companies			Signature Bonus (R$)	Area (km^2)
	Qualified	Presenting Offers	Winners		
Round 1	38	13	11	321.656.637,00	54.660
Round 2	44	27	16	468.259.069,00	48.079
Round 3	42	26	22	594.944.023,00	48.629
Round 4	29	17	14	92.377.971,00	24.351
Round 5	12	6	6	27.448.493,00	21.947
Round 6	24	21	19	665.196.028,00	39.657
Round 7	46	32	30	1.085.802.800,00	194.631
Round 8	43	27	23	587.372.561,00	11.887

of PEM as a long-term payment, in addition to the signature bonus which is an upfront payment, to receive the exploration rights in the Brazilian bidding system. Furtado (*op.cit.*) stated that in licensing rounds 6 and 7, companies' strategies to make the most competitive offer were to split the money into cash bonus and PEM as these variables have the same weight on the winning equation (eq.1). Instead of leaving money on the table as a cash bonus, as it does not bring any benefit to the winner (Tavares, 2000), companies committed large work programs to be performed during the entire exploration phase. This attitude is advantageous for the government agency that receives, besides the cash money, an assured amount of geological and geophysical data that will be released as public information in future licensing rounds.

The rules of the game impose companies to

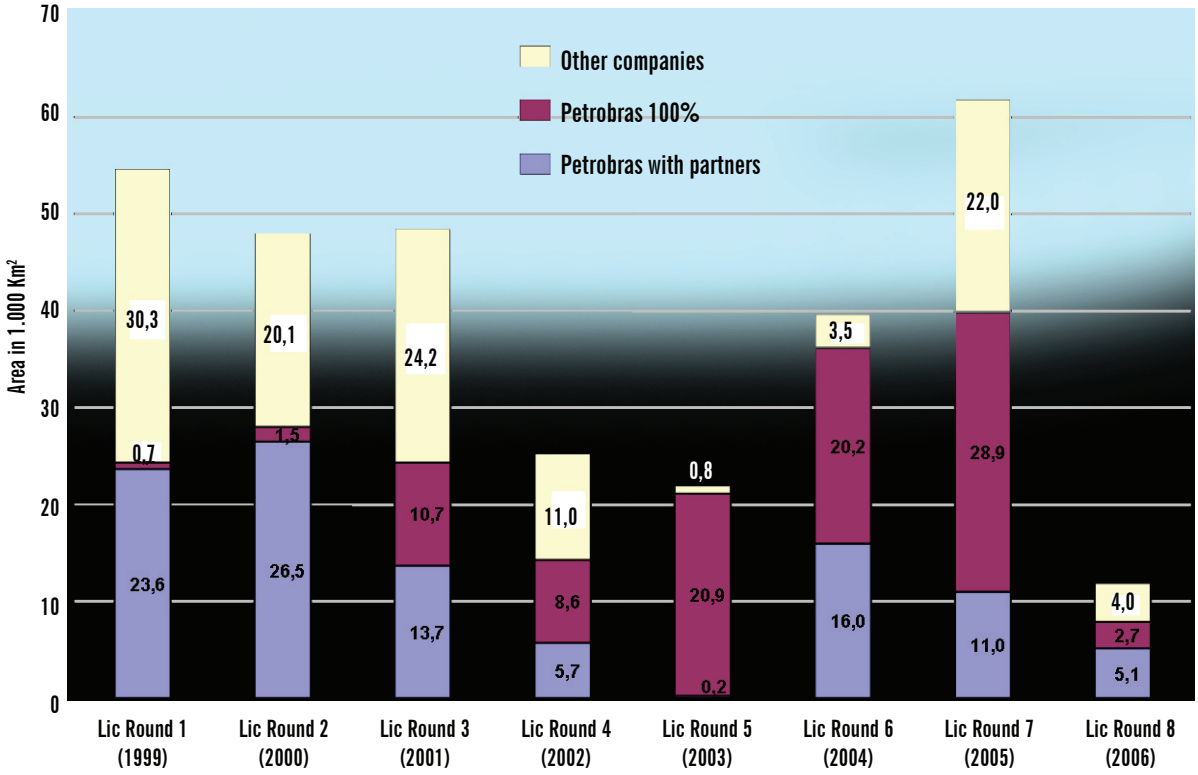


Figure 6 – Total acreage leased per licensing rounds. The colors refer to areas acquired by PETROBRAS solo (purple), companies solo or in partnerships among themselves (light yellow), and PETROBRAS with partners (blue). The data presented for licensing round 7 excludes the onshore blocks released for Solimões and São Francisco onshore basins which accounts for acreage around 130,000km²

partially relinquish 50% of the area after the first exploration period and 25% of the remaining area at the end of the second exploration period. The consecutive relinquishment impacted PETROBRAS' portfolio. There were 89 blocks under PETROBRAS concession in Round 0 (fig. 5), forcing the company decision on low acreage acquisition during rounds 1 through 4 (fig. 6). As relinquishment advances, PETROBRAS' strategy reverses to area acquisition focusing on rebuilding its exploration portfolio (fig. 6). On average, ANP leases 50,000 km^2 a year, except for rounds 4 and 5. Companies have a statistical pattern in terms of acreage acquisition, because they acquired almost the same acreage amount, around 22,000 km^2. As per reasons mentioned above, companies were not bidding alone or in partnership among themselves in licensing rounds 5 and 6, due to the risk perceived in investing in Brazil

Despite PETROBRAS participating in all licensing rounds, assuming from time to time very aggressive behavior, Figure 7 shows an actual equilibrium of acreage distribution in Brazil with PETROBRAS participating in 56% of the total acreage leased and other companies retaining 44% of almost 160,000km^2 of areas under concession contracts.

Some interesting indications from the dynamics of the petroleum auctions can be traced to the high amount of money distributed by the oil industry, which reflects their strategy based upon their records in discovering petroleum fields. For example, foreign companies that create affiliates to participate in Brazilian licensing rounds usually play the game worldwide according to their strategies. Some focus on oil findings, others gas discoveries, there are companies willing to participate in the whole petroleum chain from upstream to downstream sectors, others prefer the international market. Figure 8 present a table with names and origin of different companies that participated in Brazilian auctions along the 8 licensing rounds. This is not a complete list. Some companies are still performing exploration work and others already develop and produce oil and gas, while others are undergoing mergers, and some that completely divested from performing exploration work. In 2007, there were 33 Brazilian companies and 24 affiliate players developing exploration and production activities in Brazil.

Conclusions

As expected in the setting of oil and gas leasing, Brazilian auctions serve as an efficient alloca-

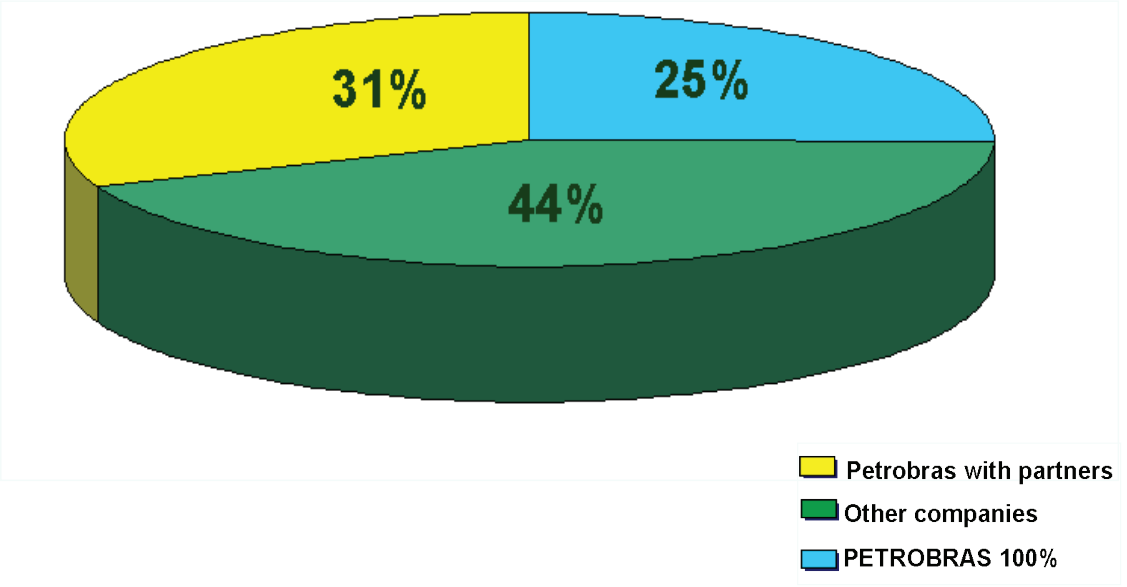


Figure 7 – Percentage of acreage distribution among companies. PETROBRAS alone retains 25% of the total acreage conceded by ANP. The other companies retain 44% of acreage and PETROBRAS with partners hold 31%, showing equilibrium in area distribution among the companies

Example of Oil Companies in Petroleum Activities in Brazil

Exploration		Development & Production
Amerada Hess (UK)	Koch (CAN)	ChevronTexaco (US)
Encana (CAN)	Devon (US)	Repsol (ESP)
Shell (NLD)	KerrMcGee (US)	Shell (NLD)
ExxonMobil (US)	Aurizônia (BR)	El Paso (US)
Statoil (NOR)	Maersk Oil (DNK)	Queiroz Galvão (BR)
ChevronTexaco (US)	BG (UK)	Inpex (JPN)
TOTAL (FR)	ENI (ITA)	Devon (US)
Wintershall (GER)	ONGC (IND)	Anadarko (US)
Norse (NOR)	Starfish (BR)	SK (KOR)
Petrogal (POR)	Partex (POR)	Hydro (NOR)

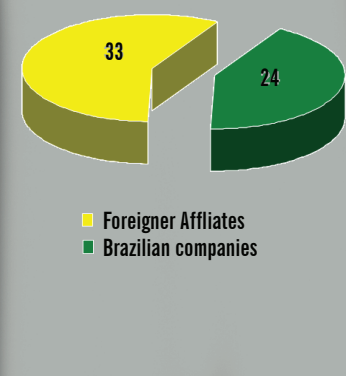


Figure 8 – A sample of companies playing the auctioning game in Brazil. Notice that some companies already have economic results from their exploration activities and are in the column of development and production. This is a picture of Brazilian players, but not definitive, because of the intrinsic and complex game of the oil industry with potential mergers, acquisitions of companies, as well as companies' international strategies which are dynamic and almost unpredictable and push companies to play around the world

tion mechanism and as resource rent taxation. As modeled by ANP, Brazilian first-price sealed bid auction provides the government with: (i) better information about companies perception of the value of a resource tract, which is obtained from the amount of work program committed by the companies; (ii) considerable revenues from the payment of the cash bonus; and (iii) national industry development, achieved by the percentage of local content bid for exploration and production phases. The dynamic of the eight licensing rounds played since 1999 has shown high interaction among the companies that can be seen as: (i) cooperating to share risks, reduce uncertainties, decrease financial exposure, and frighten competition, thus enhancing the chances for a joint venture to win the auction; and (ii) competing in order to avoid disclosing companies' risk aversion, the know-how of their technical team and economic criteria.

The results generated by the bidding rounds are fundamental in the Brazilian regulatory scheme for petroleum exploration and production. The creation of clear rules and the high level of confidence among the players in the process lead to an open scenario to attract new players. Another aspect is the competition attesting to the auctions' success as well as the governmental rents (tax, fees, and participations) that gives opportunities for various stakeholders (municipalities, states, R&D developments, environment sectors etc.) to benefit for the oil and gas activities. Some adjustments made during the last bidding process bring important balance and an equilibrium of the distribution of the areas leased among the players, including PETROBRAS. In this sense, it is important to emphasize that using cash bonus as upfront money and PEM as a long-term payment enhance the chances of the companies to win the high potential areas on offer without putting all their eggs in one basket.

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