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A Lognormal Model for the Bidding Process in Brazil

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Abstract
The recent changes of the legal framework in Brazil created new forms of exploration process and acreage availability after the first bid round in 1998. Since this period three bids rounds were accomplished in Brazil, where 103 blocks were leased and collected about of US$ 700 million, involving more than 43 oil companies. This paper attempts to delineate the main features and statistics of those bids and the impacts on the exploratory efforts for new oil and gas discoveries. Based upon the winners curse theory, a lognormal model is fitting to the data set in order to explain the competitors' behavior in a typical competitive lease environment. The lognormal model provides an optimum region in the curve where bidders can both avoid the winners curse and win the lease, considering the budget restriction and the their own goals. The simulation of the last two bids indicate a new exploration pattern towards the frontier areas, where a high risk/high return zones are expected.

Introduction
The new concession process for oil and gas exploration through competitive bidding marks a significant step in the opening of Brazil's petroleum sector. The range of opportunities on offer is considerable, with most of the geological provinces being represented. The blocks covered the main basin settings: onshore rift, offshore rift to passive margin, and passive/wrench margin.

The Brazilian National Petroleum Agency (ANP) grants the rights of blocks exploration through sealed bidding method, i.e., bonus are made by the participants without knowing the other competitor bonus and how many competitors will go to play the game.
Since 1998 three bids rounds were accomplished in Brazil, where 103 blocks were leased and collected about of US$ 700 million, involving more than 43 oil companies and 280 Km^2 of area (Simões Filho, 1999; ANP,2001). Figure 1 indicated the main rules using by ANP in the licensing rounds.

Rose (2001) pointed out that this method is most detrimental to operators and brings some advantages to the government. The sealed bonus bidding has two main unavoidable constraints to the operators – the winner's curse and the ubiquitous

overbid. Based upon that restrictions a company that enters in the sealed bonus bidding can consider two distinctive objectives: maximizing the oil and gas reserves and maximizing the profits. A reserve maximizer firm seeks reserves constrained only by the expectation of not losing economic present values. A value maximizer seeks the largest possible increase in economic present values with whatever the reserves are coincident (Lohrenz, 1987). Therefore, the company estimates the value of the block and its bidding is based on a fraction of this value. This value can be an overestimation or an underestimation of the block real value.

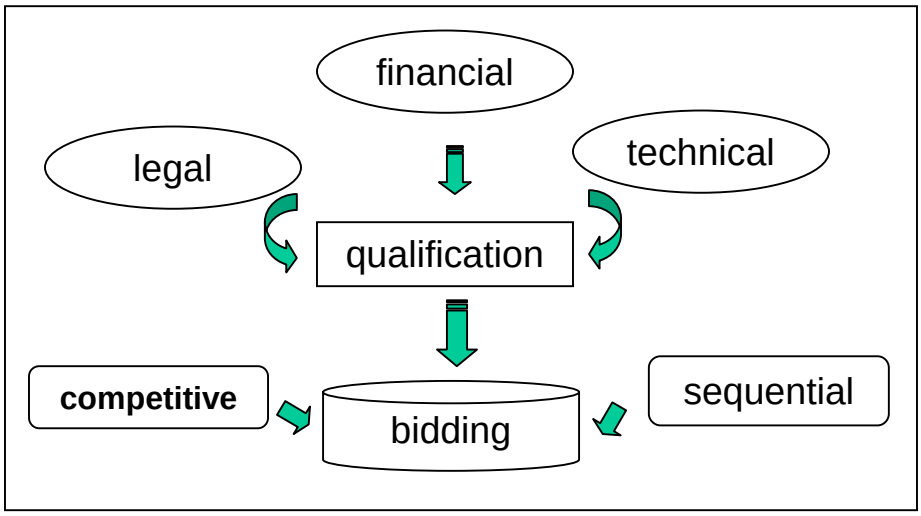

Figure 1 – Licensing rounds: general rules

This paper attempts to delineate and describe the main features and statistics of those bids and the impacts on the exploratory efforts for new oil and gas discoveries in Brazil. Based upon the winner's curse a lognormal model is fitting to the data set in order to explain the competitors' behavior in a typical competitive lease environment. The proposal of this work is also to verify the magnitude of bonus bid values in a new exploratory acreage market and to adjust a *lognormal* probability distribution model the winner bids output in the three rounds already accomplished by the agency in Brazil.

Methodology

Before investing in a competitive bidding (sealed bonus bidding), a company evaluates the block with information supplied by the local agency. The parameters involved in the exploratory program has many uncertainties and they can be describe in the following way:

- Oil and gas presence;
- Volume of the deposits;
- Possible profits;
- Reasonable bids (public and transparent process);
- Possible competition;
- Regulatory regime.

The variables involved in a bidding process are related with the geological and economical uncertainties of the block. These uncertainties, when receive an adequate statistical treatment (i.e.: the available data fits with a known statistical distribution), they become defined risks with an expected value and the standard deviation. As mentioned previously, the auction process involves a wide range of risk variables, which are random variables, where the bonus value is obtained through an interaction of two or more variables. Because the product of two random variables is also a random variable, each competitor's bid is a random variable. The observed size distribution of mineral deposits and the central limit theorem lead us to expect that the distribution of bids for a tract should follows a *lognormal* probability distribution (Dougherty and Nozaki, 1975) with expected value (average) and risk (standard deviation) well characterized and defined.

After the data are fit to a lognormal distribution, an evaluation of the model will be made to define the optimum region in the curve (directly related with the preferences of the company) that can avoid both the winner's curse and ubiquitous overbid. The winner's curse in petroleum exploration was discussed by Capen et al. (1971) and can be defined by two scenarios: if a block (or a geological tract underling) turns out to be productive, there is a possibility of overestimation of its net present value (NPV), and therefore the firm will not get a good return. Contrarily, if the block is dry, the firm overestimated the expected value and paid too much for it on a risk-reward basis. The ubiquitous overbid can be defined simply as the money left on the table, i.e., the difference between the winning bids and the second bids (Megill and Wightman, 1984). Overbids are characteristically large, simply because bids – based mostly on reserves potential – are *lognormally* distributed, hence the difference between the first and the second bid is generally large, compared with, sequentially, for example, the fifth and sixth bids, because of log scale. Then, overbidding is part of the mathematics and cannot be eliminated.

Results

Brazil rounds 1, 2, and 3 were considered jointly. In this evaluation, a descriptive statistics of the winner bids were made. Figure 2 indicates that the winner bids are *lognormally* distributed. The continuous line is the adjustment of the l*ognormal* fitting of the input data. A Kolmogorov-Smirnov test was performed, given a hypothesis acceptance of 90%.

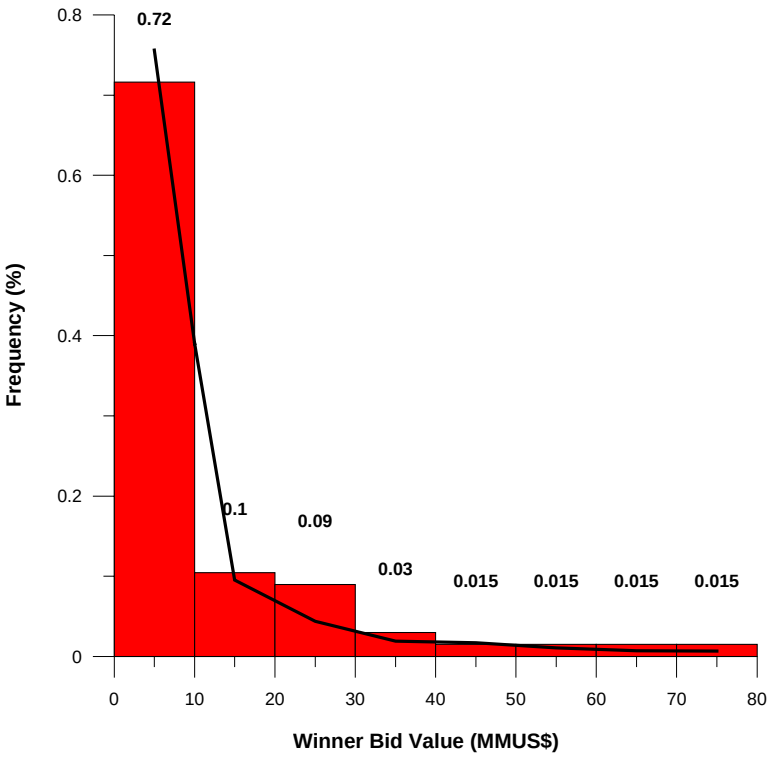

Figure 2 – Winner Bid Value Histogram of Brazil Round 1, 2 and 3

Another procedure was utilized to verify the lognormal behavior. The winners' bid values were ranking sequentially from the highest value and normalized. So, instead of plotting the bid frequency over all bids, a cumulative probability of bid value versus bid made was plotted (Figure 3).

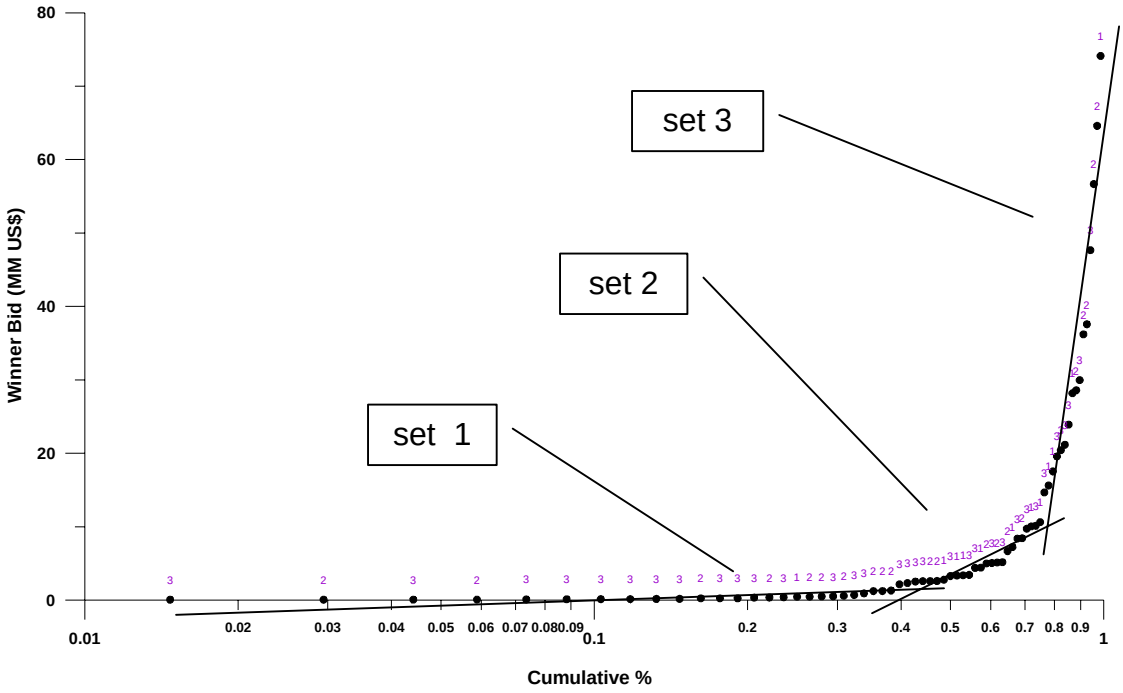

Figure 3 – Set of winner's bid values: Round 1, 2, and 3

Figure 3 depicted three different groups (or sets). The first group indicated that the winner bonus had the smallest values. Most blocks of this group were bidding in second and third round (set 1). The second group has a more complex pattern, representing a mixture of blocks from the three rounds (set 2). It is important to remark that the competitors evaluated these blocks in an optimistic way in our sample, and the winners' bonus values are close to the sample average (US$ 17 million). This can easily been inferred considering that approximately 83% winners' bonus values are included in this group or below it.

In the third group the winners' bonus values are the most optimistic or they can be called overestimated values (set 3), i.e., the expected profit value can have be overestimated and the company may suffer the winner's curse. In this group there are a predominance of first and third rounds values. This bonus values are in the upper tale of the *lognormal* probability distribution and represents about 10% of total bids.

To summarize, about 95% of the total blocks (about 61 blocks) had inferior winners' bonus below of US$ 30 million. This finding indicates that to have a good competitive bidding performance in Brazil, a bidder should bet values above of the average values, but never above of USS 30 million to avoid the winner's curse based upon the actual historical sample (3 round bids).

In a competitive bidding the overbid is always present and it is the second important goal that a company should manage. Considering that this constraint cannot be

eliminated, the firm should keep an effort to reduce and manage wisely the overbid by gaining good geological and economic information.

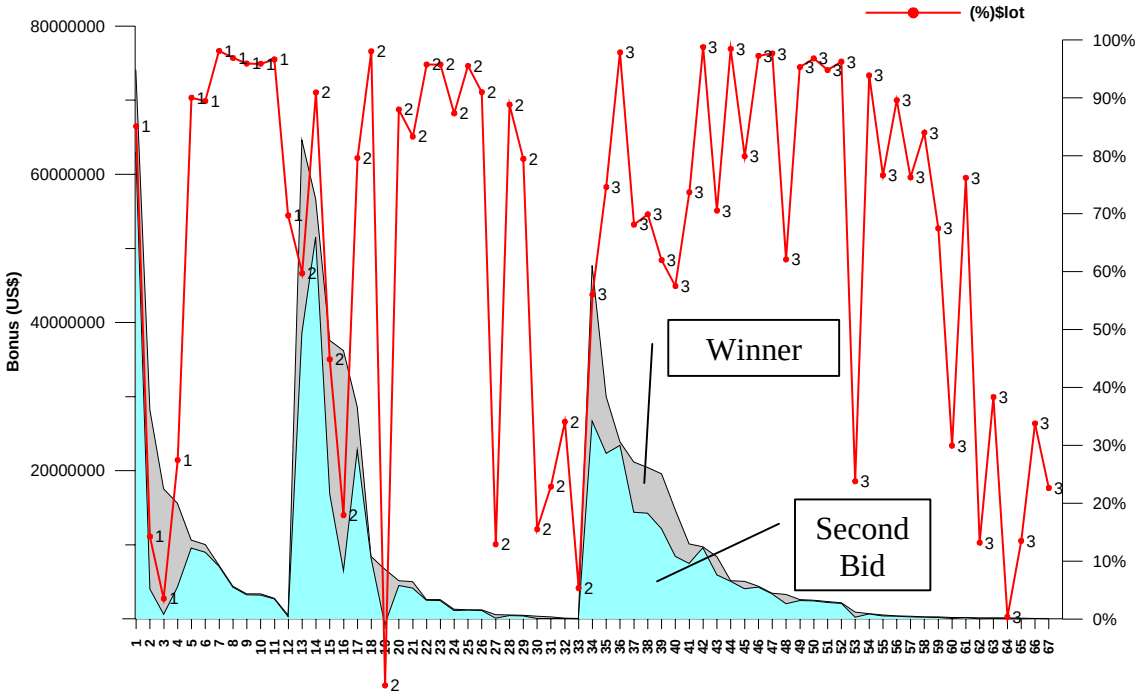

Figure 4 – Ubiquitous Overbid in three rounds

Figure 4 indicated the winner's bonus ranking in a decreasing order, separate by the rounds. The vertical axes represented the value paid by the competitors (left side) and the overbid percentage (right side). It can be observed that the overbid trend showed an apparent decrease. The blocks acquired in the first round presented a higher and the best level of geological information. Moreover, it was the first time that Brazil made a bid in petroleum sector and few blocks were being offered, this could explain the high level of competition between the companies, causing high value of overbid.

In the second round, the blocks presented a mixture pattern including areas with no exploratory wells and areas that already previously known, with more available data. There is big overbid fluctuation in the second round, demonstrating lesser homogeneity between the winner's bonuses. In the third run, overbid had apparently fall, a trend that seems being followed since the first round, indicating that the companies acquire a better level of knowledge of the local regime and the geological basins, conducting the bidders to evaluate the blocks more accurately.

According to Rose (2001), the overbid average of the Gulf of Mexico up to 1983 was 50%. However, after 1983 this average grew to 75% due to a reduction of competition level. In Brazil the average is about 70% (Figure 4), but with a high level of variability that makes difficult to forecast the overbids for the future rounds. The future bonus in

Brazil will depend much on the possible discoveries in the blocks that already had been bid on and the level of competition for new oil frontiers in deep-waters worldwide.

It can be observed that there is a negative overbid in round 2. This is an incentive in the Brazilian bid process, that the winner company accumulates the biggest number of points relating to the bonus value and firm commitment with domestic suppliers in the exploratory and development projects phases. This was the only case among the 67 blocks acquired during the three bidding rounds in Brazil.

Conclusions

The results showed a balanced population of players in Brazil and represented a first insight of future oil opportunities in a new opening market. The proposed lognormal model is an attempt to describe the main trends of the three round bids in Brazil. An exploratory appraisal analysis cannot neglect bonus value, because it's a sunk cost in the decision process and must be recovered in the future by firm in the new ventures. Despite the high variability, the three rounds presented an overbid average of 70%, within the range of world acreage available regions.

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