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AN EMPIRICAL OBSERVATION ON BIDDING BEHAVIOR IN IRANIAN ELECTRICITY MARKET

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***Abstract*— Following the global experiences, and the governmental resources' scarcity to develop the electrical infrastructures, Iranian Electricity Market is inaugurated in 2003. One of the main objectives of restructuring in this industry, in Iran, was decreasing the government's duty in the areas which natural monopoly does not exist. With this in mind, this paper will focus on the bidding behaviour of the private and the government sectors during summer and winter 2013, to not only explore the effect of demand on market behaviour, but also detect the difference between these two sectors in forecasting the market. For this purpose, the average number of accepted generators, the accepted bids, and the days which generators have bided MCP, in each sector, is computed. Results show that, governmental units are the ones that are bidding MCP the most.**

***Keywords*— Bidding Behavior; Electricity Market; Pay- as- Bid Auction**

I. INTRODUCTION

Electricity is an industry with the largest impact on our lives. Historically, this industry was assumed a public service, which was monopolistic. Due to the issues with monopoly as well as the global trend of restructuring, the Electricity Market has been setup with the aim of increasing efficiency, reducing costs, and improving quality of service. Since 1980s, electricity market in developed countries started restructuring. Following the global experiences, the Iranian electricity market has inaugurated in 2003.

One of the main objectives of restructuring in this industry, in Iran, was decreasing the government's duty in the areas which natural monopoly does not exist. With this in mind, this paper will focus on the bidding behaviour of the private and the government sectors during summer and winter 2013, to not only explore the effect of demand on market behaviour, but also detect the difference between these two sectors in forecasting the market.

For this purpose, the average number of accepted generators, the accepted bids, and the days which generators have bided MCP, in each sector, is computed. Results show that, governmental units are the ones that are bidding MCP the most.

One of the main engrossing specifications of this study, is implementing the analysis on the Iranian Electricity Market which is one of the few markets with pay- as- bid auction.

Indeed, IGMC publishes minimum accepted price, maximum accepted price and weighted average prices. However, to avoid exercise of market power by some companies, maximum accepted price is often reported as market's price cap [1]. Thus, most studies have used weighted average prices or price cap for their analyses [1] [2] [3] [4]. As weighted average prices, could be affected by small bids of risk-averse participants, it could not be a good price signal.

Thus, in contrast to previous studies, in this paper, market clearing price is calculated and employed to examine bidding behavior of private and government sectors.

The remainder of this paper is as follows: in section 2 previous studies have been discussed. Section 3, expresses the methodology of the paper. Section 4 includes the results and the paper is concluded in section 5.

II. LITERATURE REVIEW

The bidding behavior is surveyed in several studies. Reference [5] examined bidding pattern in England and Wales' Electricity Market. Results confirm strategic bidding in this market.

Reference [6] studied bidding behavior in first three months of operation of National Electricity Market of

Australia. Results illustrated that financial hedge contracts affect bidding strategies in this market.

Reference [7] analyzed bidding pattern in Australia's National Electricity Market to identify generators' strategies and market power. For this purpose, they have considered generators' behavior during peak, off- peak and shoulder periods and they have classified generators to active, moderately active and inactive based on their respond to the market conditions. They have also identified capacity withholding by comparing capacity commitment in peak, shoulder and off- peak hours. Results show that large companies have tendency of capacity withholding during peak hours and capacity shortages may cause this phenomenon.

Reference [8] presents a statistical model to analyze bidding behavior in the New York's Electricity Market. In this paper, 325 generators' bids were categorized into five groups based on their maximal bids and then bidding behavior is simulated. Investigations confirm that demand's effect on market prices is significant.

Reference [1] analyzed bidding behavior of generators in the Iranian Electricity Market. First, they discuss about the number of steps that generators used in bidding procedure. Their investigations show that 15% of generators use parts of their bidding curve to identify market status. Then, they evaluated demand's effect on bidding distribution in peak, shoulder and off-peak period. Results show that bidding behavior of generators depends on demand rates and price peaks, and load peaks do not coincide in summer 2011 because of the risk aversion policies in load peaks.

Reference [9] examined bidding behavior in Chilean Electricity Market during 2006- 2011. In this paper, a theoretical framework is built to explain generators' bidding behavior in terms of expected spot prices and contracting positions. Results indicate evidence of significant barriers to entry. However, this paper did not consider the dynamic implications of having sequential auctions.

III. METHODS

The main purpose of this paper is examining bidding behaviour in pay- as- bid auction. Thus, this assessment is applied to the Iranian Electricity Market during 2013. Before 2011, bids data were not publicly available. Thus, there could not be any analysis on the results. Although this data is publishing since 2011, it is still unknown that each bid belongs to which generator. In fact, random codes are given to the generators each day. Nonetheless, some technical characteristics of generators are also published that are constant during the year and can be used to identify the generators. We have grouped the generators into public and private based on the technical properties of them, which will be published by their bids and then, compared the results. These components consist of the minimum and also the maximum power that the generators could produce and the incremental ramp rate.

The demand and the supply curve are derived from the Iran Grid Management Company [10]. The demand is assumed inelastic. In fact, there are two main reasons for why electricity demand is assumed to be inelastic. First, in most countries like Iran, the retail prices are kept regulated rather than the wholesale prices. Therefore, the consumers have no incentives to reduce their demand at higher prices. Indeed, the wholesale price fluctuations do not pass to retail customer [11]. Second, the firms providing electricity in the wholesale market are mandated to provide power at any cost [12].

The bid data, is arranged ascending to make a supply curve. Hence, by intersection of the demand curve and the supply curve, the market clearing price (MCP) will be obtained.

Hour 7 and 21 have been chosen as an off- peak and peak hour, respectively, to compare the results. As the Iranian Electricity Market is running under the pay- as- bid auction (winners will receive their bids), forecasting MCP could be a goal in this market. As the average numbers of producers, varies during the seasons, to eliminate the effect of the number of generators on MCP and accepted bids, the average of these factors is computed. For this purpose, each sector's share in bidding MCP is divided by the number of generators in that group. Moreover, accepted bids per genco are computed by dividing each sector's share in accepted bids by the number of generators in that group.

The available data, for 365 days during March 2012- March 2013 is employed. The demand and the actual supply curve are derived by the Iran Grid Management company. All the computations are done with MATLAB R2012a software.

IV. RESULTS

In this paper, bidding behaviour is assessed under Iranian pay- as- bid Electricity Market. For this purpose, bidding MCP is assessed. Figure 1 shows the MCP fluctuations during the entire year. It is clear that increase in demand is causing the increase in bids. However, it is still unknown that which group of generators are bidding MCP the most.

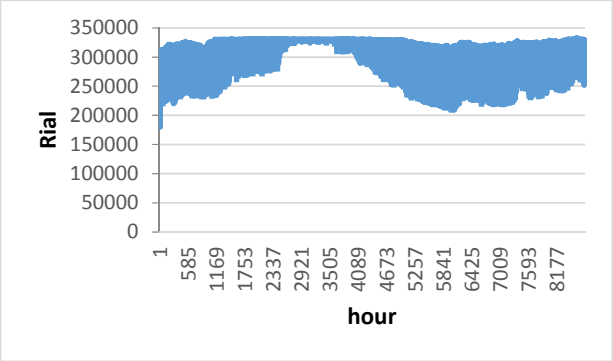

Figure I. MCP fluctuations during 2013
Source: Calculations

Table 1 shows the results under off- peak hour. This table shows that by passing through the seasons from summer to winter, as the demand decreases, the number of generators will decrease. However, governmental generators have bided MCP the most, both in summer and winter.

It is notable that accepted bids per genco for government producers are less than private generators, during summer. Conversely, during winter, private sector, have the less accepted bids. In fact, the more average in bidding MCP, means that governmental generators are forecasting the market well.

However, why do they have the less accepted bids in summer and more accepted bids in winter? To answer this question, we need explaining some rules in the Iranian Electricity Market. In the Iranian Electricity Market, apart from the market results and the winners of the market, steam turbine, were being dispatched as they can not be on- off, quickly. Indeed, generators which produce more than what they have won in the market, have to pay a penalty for the amount of increase in their production. In fact, in this condition the energy price is moderated and the generator would receive its average variable cost instead of its bid.

Nonetheless, this rule still has a bug. The problem arises as this fine will be forgiven, if the generator, produce more than 1.05 of its accepted bid (The 1.05 has changed to 1.15. However, at the time of this study it was 1.05) [13]. Thus, part of the accepted bids for these generators, is employed to reduce their risk of their fine. Government generators are mostly steam turbine. Thus, in summer, the less accepted bids of government sector, is based on this rule.

Indeed, there is another fact that increases the accepted bids of government sector, in winter. As the government sector is funding by the government, they are managing their bids by their budget. In other words, they are not bidding to maximizing their profit. They just try to match their income with their budget. Thus, as winter, is the end of the financial year in Iran, they will decrease their bids in winter. Consequently, the number of their accepted bids will increase.

Table I. Hour 7 results during summer and winter

	Summer		**Winter**	
	Private	***Government***	***Private***	***Government***
MCP per Genco	0.002808538	0.003712238	0.003381643	0.006284153
Accepted bids per Genco	0.0037158	0.002988588	0.004873961	0.005440137
Genco Counts	134	168	69	122

Source: Calculations

Table 2, shows the similar results during winter and summer under peak hour. Indeed, under the same season, passing through the off- peak hour to the peak hour, does not affect the whole result. In other words, government sector is predicting the market well, by bidding the market clearing price (MCP) the most.

It is crystal clear that during peak hours of summer which is the peak season in Iran, the number of generators have increased. However, in average, government sector is predicting MCP better than private sector compared to off-peak hour.

In winter, there are other reasons that have decreased the ability of private sector to predict MCP.

First, private units are mostly gas turbine generators during 2012-2013 (This has changed. However, at the time of this study, private units were mostly gas turbine.) [14]. Thus, they have the higher AVC compared to steam turbine and combined cycle power plants. Indeed, in winter, when demand falls, they may have higher AVC than the MCP. Thus, they could not win in the market.

It is notable that during winter, there is another constraint which limits the competition. Fuel limit is a constraint which determines the winners.

Thus, second reason will be the fuel limit which is also a reason that they can not bid at MCP during winter.

Table II. Hour 21 results during summer and winter

	Summer		**Winter**	
	Private	**Government**	**Private**	**Government**
MCP per Genco	0.001109955	0.003663527	0.002442002	0.004801097
Accepted bids per Genco	0.002745687	0.002541675	0.003803582	0.004036259
Genco Counts	155	226	91	162

Source: Calculations

V. CONCLUSION

The Iranian Electricity Market has been restructured in 2003. With more than a decade of restructuring in hand, it is still unknown that this regulation has gained its goals or not. Before 2011, bids data were not publicly available. Although this data is publishing since 2011, it is still unknown that each bid belongs to which generator. Thus, there could not be any analysis on the outcome of the specific generator.

This paper, grouped the producers based on their technical properties which is published with the bids, to the governmental and private. Then, results were compared under summer and winter which are the peak and off- peak seasons in Iran. Indeed, in each season, an off- peak and peak hours are chosen to investigate the result.

The MCP per genco and the accepted bids per genco, which show the winning with the maximum profit is computed. Results show that government sector is forecasting the market well. In fact, they are gaining profit from the rules of the market. As they own mostly steam turbine and combined cycle power plants, which run with the least variable cost, it is expected that they have the least bids.

However, they are bidding the MCP the most. In fact, they are gaining profit from some specific rules of the market.

REFERENCES

[1] A. Darudi, N. Yekyai and M. H. J. D. Bayaz, "Bidding behavior analysis of generating companies in Iran's electricity market," 2013 13th International Conference on (pp. 319-323). IEEE.

[2] M. H. Asgari and H. Monsef, "Market power analysis for the Iranian electricity market," Energy policy, 38(10), 5582-5599, 2010.

[3] M. Zarezadeh, A. Naghavi and S. F. Ghaderi, "Electricity price forecasting in Iranian electricity market applying Artificial Neural Networks," Electric Power Conference, 2008. EPEC 2008. IEEE Canada (pp. 1-6). IEEE.

[4] A. Nazemi and M. Mashayekhi, "Competitiveness assessment of Iran's restructured electricity market," Energy Economics, 49, 308-316.

[5] C. D. Wolfram, "Strategic bidding in a multi-unit auction: An empirical analysis of bids to supply electricity," National Bureau of Economic Research, 1997.

[6] F. A. Wolak, "An Empirical Analysis of the Impact of Hedge Contracts on Bidding Behavior in a Competitive Electricity Market," International Economic Journal, *14*(2), 1-39, 2000.

[7] X. Hu, G. Grozev and D. Batten, "Empirical observations of bidding patterns in Australia's National Electricity Market," Energy Policy, *33*(16), 2075-2086, 2005.

[8] N. Zhang, "Generators' bidding behavior in the NYISO day-ahead wholesale electricity market," Energy Economics, *31*(6), 897-913, 2009.

[9] J. Bustos- Salvagno, "Bidding behavior in the Chilean Electricity Market", Energy Economics, pp. 288- 299, 2015.

[10] IGMC Website, Iran Grid Management Company, Available at: www.igmc.ir

[11] Y. Ren, "A Comparison of Pay- as- Bid and Marginal Pricing in Electricity Markets," Ph.D thesis, McGill University, 2008.

[12] E. T. Mansur, "Upstream competition and vertical integration in electricity markets," Journal of Law and Economics, No 1, 125-156, 2007.

[13] Iran Grid Management Company (2012), *Instruction on computing base quantities in production account*.

[14] Tavanir (2013), *Electricity Industry Production Statistics*, Iran Power Ministry, Tehran, Iran.

[15] Iran Electricity Power Statistics, 2012, Available at: <http://amar.tavanir.org.ir>