SIMULATING CAPACITY AUCTIONS WITH *econport*

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ABSTRACT

A simulator environment to study and understand capacity auction has been developed based on the on-line web simulator *econport*. The goods to auction are unloading rights for ships that transport liquefied natural gas (LNG) into harbours. Experiments have been carried out at a company that will participate in the future capacity market. The efficiency of the auctions both for the auctioneer and the bidders is assessed.

INTRODUCTION

It is not easy to find an industry in Europe that goes through such drastic changes like the ones observed in utilities markets. The deregulation of the international energy markets means utility companies are facing completely new challenges, and these shifts will continue for several years to come.

The EU directives on the liberalization of the electricity and the gas markets require large capital investments as well as new management tools. However, both should be studied, analysed and designed in parallel.

One of these changes relates to the development of markets in every stage of the supply chain. Besides the utilities markets currently available for the products or commodities, the trend is to develop capacity markets, that is, the rights to move the product along the supply chain. In particular, this article focuses on the necessity to understand the rules that would govern the capacity auctions related to the rights to offload LNG from ships into harbour tanks. More specifically, time slots for offloading are to be auctioned by the corresponding governmental agency.

This type of auction is similar to the one carried to assign slots at airports. In Spain and LNG, the only auctions that are currently underway are those of the reservation of space at underground storages (CNE 2012).

There exists therefore the need to understand the dynamics of the capacity auction markets through the use of a simulator. Moreover, it is possible to test the simulator under different scenarios at a company that will be participating in the real capacity market when it will be developed by the Spanish authorities.

Auction simulators have been extensively used in research and teaching in computational and experimental economics (Kagel and Roth 2011), showing that these simulators might be particularized adhoc for the real situation. In that sense we employ, for the first time to our knowledge, an auction simulator which has been particularized to study capacity auctions in general and in the energy market in particular.

Out of the available options, we select *econport* due to its wide use and its functional interface (Chen et al. 2003; Cox et al. 2005), as well as its enormous parameterisation potential that favours its particularisation to capacity auctions.

Section 2 further defines the process to offload the LNG and the related capacity rights. Section 3 is devoted to *econport* and its options while Section 4 is used to parameterise the software to favour capacity auctions. Section 5 describes the experiment that has been carried out at a participating company. Section 6 is devoted to explain the restrictions of the software in its current state as well as the possibilities of the tool in teaching and research while Section 7 is used to conclude and to define new lines of research.

OFFLOADING OF LNG SHIPS AND AUCTION RIGHTS

Companies that wish to offload LNG at the harbour tanks have to reserve or buy capacity, since the resources are very much limited. The usage of the harbour facilities have been addressed in the literature using simulation (Bruzzone et al. 1998; or more

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recently, Gyoungwoo et al. 2009), including the problem when unloading ships that carry coal (Otamendi 2008) or the loads on LNG terminals (Rezende et al. 2007).

The procedures to reserve capacity are currently known by the players, but may be rapidly changed, according to the Spanish regulation set back in December of 2007. There is a trend to liberalize the markets by installing auctions at any of the supply chain stages. In addition to those available for the price of gas and LNG, markets will be also set for capacities, that is, for allocation of capacity slots at the harbours for offloading, at the plants for regasification, at the network for transportation or at the underground buffers for storage. In Spain, the auctions started in 2009 with the underground storage capacity auction (CNE 2012). It looks like the appropriate time for the companies to understand the new system and rules and develop platforms which will help in the new auction era.

Let's further define the offloading system. A company buys LNG that is transported by ship and must be offload at a harbour. Ships or tankers are usually large. The investments in LNG are therefore high and the price to pay for not offloading at the proper time is ever increasing with the delays. The size of the tankers will also force the company to buy just a few offloading rights over a long period of time. So timing is very important and bidding for the proper slots in critical.

The competitors should not be large in number. The value of offloading at the required time should also be similar for each competitor, and so should be the penalties for lack of timing. As of right now, a secondary market does not appear to be necessary, although over-the-counter (OTC) transaction should take place to trade rights.

Therefore, the companies that are going to to participate in the auction and buy offloading rights must learn how to proceed in this new situation and design strategies that will allow them to maximize their profit while maintaining the reliability of service. If a simulator existed that resembled the capacity auctions…

econport and CAPACITY AUCTIONS

econport was designed by the Experimental Economics Center of Georgia State University back in 2006 as an experimental tool to research in economics. It has one module that allows for simulating auctions. In particular, it has one routine that resembles one market in which one seller offers several goods to different bidders. This module could be used as the basis for simulating capacity auctions.

General Options and Use

To set an experiment, the auctioneer sets the following parameters:

- Number of goods or consecutive periods in which one good is auctioned at a time.
- Value of the goods, which might be individually set by hand or randomly assigned according to a uniform distribution
- Type of auction among four possibilities:
  a) Sealed-bid auctions: all the bidders submit simultaneously a single bid within the allotted time.
     1. First price: the good is awarded to the bidder who has submitted the highest bid.
     2. Vickrey or second highest price: the good is awarded to the bidder who has submitted the highest bid, but at the second highest price.
  b) Dynamic: the bids keeps on varying along time, which is limited by design.
     3. English or ascending: the bids keep on rising until time is over. The good is awarded to the bidder who has submitted the last bid.
     4. Dutch or descending: The price keeps decreasing following a preset clocked pattern until one bidder stops the proceedings by accepting and paying the current price.

The auctioneer posts then the experiment on the web and sends instructions to the bidders, including a password (Figure 1).

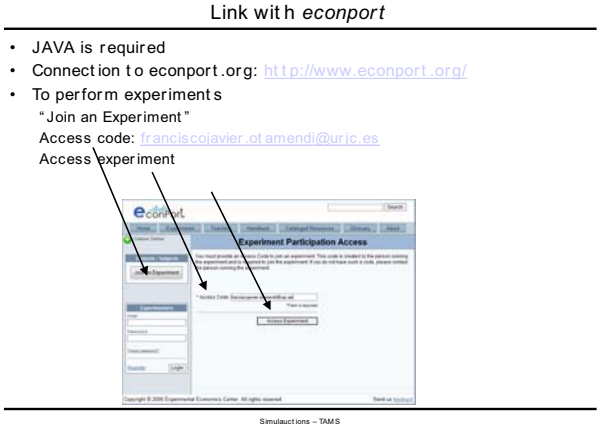

Figure 1. Platform access

Each bidder might then join the experiment and send a message to the auctioneer with the username (Figure 2). Once all the bidders have logged in and showed their intention to participate, the auctioneer starts the simulation.

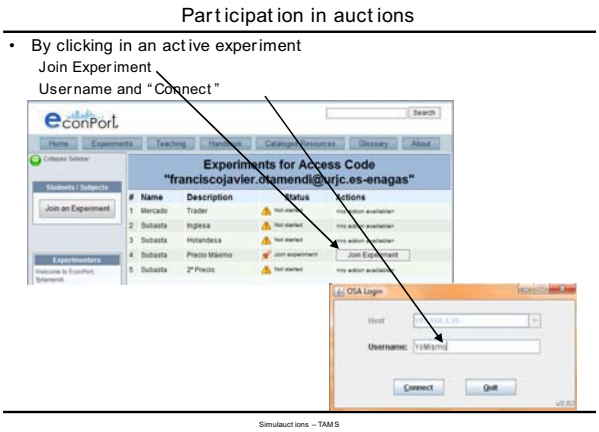

Figure 2. Intention to participate

The bidder must then place a bid if the good is of his interest. Each bidder knows his value for the good, the feasible values for the bids, as well as the number of competing bidders (Figure 3).

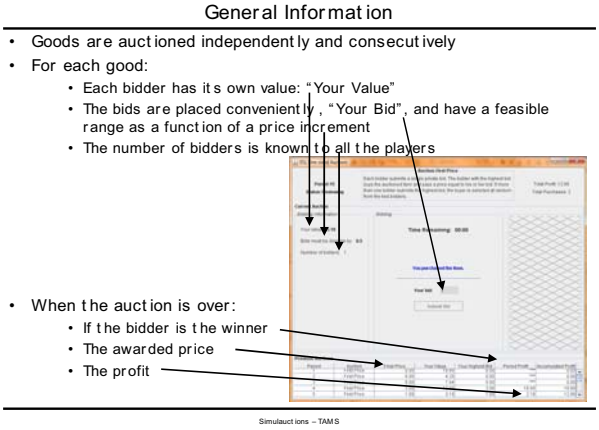

Figure 3. General information for the bidder

After a good is sold, each bidder knows the selling price, but not the name of the awarding bidder (bottom of Figure 3). He also gets information about his performance in terms of profit, calculated as the difference between value and bid. The profit accumulates after each good is sold. The auctioneer also gets information on a summary screen, which includes number of purchases and profits per bidder (Figure 4) and the relationship between values and bids (Figure 5).

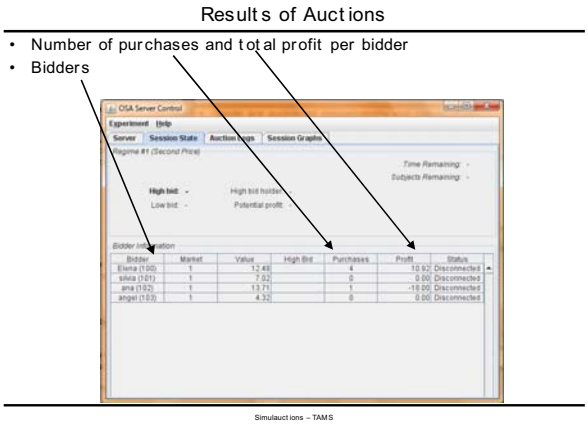

Figure 4. Auctioneer information about purchases and profits

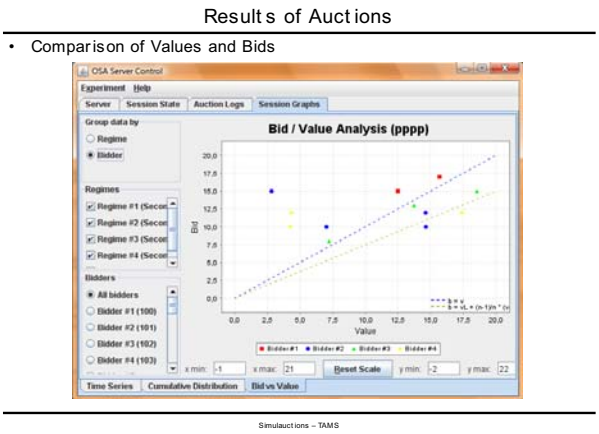

Figure 5. Auctioneer information about values and bids

Parameterisation for capacity auctions

econport must be parameterised to correctly represent the capacity auctions and for allowing for the comparison between types of auctions.

Since slots or rights are auctioned, the first decision is to determine the number of periods or goods to auction in each period. There are some markets, mainly commodity markets that offer all the goods at once, and the bids are for a certain number of rights (Capen et al. 1971; Iledare et al. 2004; Fitzgerald, 2010). Multiple rounds might be held until there is a match between supply and demand. Capacity auctions favour however one-right-at-a-time auctions due to the importance of the timing of the offloads. *econport* allows for the setting of different consecutive periods in which one good is individually auctioned.

The second decision is to determine the length of each of the auction periods. To allow for comparison across auction types, the same length should be set for each of them. While the time for sealed bid auctions (high price and Vickrey) is intuitively set, the pure English ascending price auctions do not have a time limit other than the one set by the auctioneer after a bid has been provided. *econport* allows also for a total time limit

which could be set for making the English auctions comparable to the sealed-bid auctions.

However, Dutch auctions are very different in nature. The time is set by the starting price set by the auctioneer as well as the price decrement between calls. If the starting price is high and the decrement is low, the auction time might be very long. These two decisions restrict the way the parameters are set across auction types.

The decrement should be set by the price units. The monetary units are cents, so 0.01 should be the decrement. The starting price sets then the maximum time that will be spent on the auction.

A total period length must then be set. It will be fixed for all the auctions other than the Dutch. For this auction the starting price will be set so that the auction does not last longer than the one fixed for the first three types.

Then, the value of the right assigned to the bidders is of critical importance. The starting price should be somewhat higher than the value, but close to it so that the auction price gets close to the bidder values soon.

TESTING THE SIMULATOR

General rules

Several experiments were carried out to validate the simulator and test its virtues to explain auction concepts and study strategies both for bidders and auctioneers within the capacity markets in general and LNG offloading rights in particular.

For any experiment, the simulation period was divided in 5 slots or rights, so up to 5 tankers are liable to be offloaded. Each auction period lasted 65 seconds: 5 to read the instructions and prepare the strategy and 60 to participate in the auction and bid. Each experiment was going to be tested under the rules of each of the four auction types (4 scenarios per experiment).

Almost all the experiments were set so that the average market value of the right (V*) is the same for all the bidders, although the individual values might be stochastically varied even between periods.

The session at a participating company was held on March 29th, 2011. Four teams of two people freely bid on the following auctions:

- The values were sampled from a distribution of values (V dist) that follows a Uniform distribution that ranges between 0 and 20, U(0,20).
- The values were basically constant, "common values", and sampled from a distribution of values (V dist) that follows a Uniform distribution that ranges between 9.9 and 10.1, U(9.9,10.1).
- The values were constant, "common values", but varying between periods (10, 10, 12, 8, 10).

The results that were successfully stored in *econport* are shown on Figure 6. All the 12 combinations (3 values * 4 types of auctions) were performed but some of the results were lost as they have to be stored in separate files in the system by the auctioneer (instead of by the system itself). Over-writing of files was not known at the time of the experiment.

The main result of the profits were calculated for each period or right as (Value-Bid), and averaged over the 5 rights. It is striking to see that the bids are very similar to the values, which corresponds to players that are professionally related to the field of study.

Profit (Average)

			Auction Type				
Date	V dist	Name	First Price	Vickrey	English	Dutch	Total general
29/03/2011	U (0,20)	A	0.20		2.08	0.68	0.99
		B	0.00		0.00	0.09	0.03
		C	0.66		1.44	0.00	0.70
		D	0.04		-1.34	0.22	-0.36
	Total U (0,20)		0.22		0.55	0.25	0.34
	U (9.9, 10.1)	A			0.00		0.00
		B			0.23		0.23
		C			0.09		0.09
		D			-0.39		-0.39
	Total U (9.9, 10.1)				-0.02		-0.02
	Common but not fixed (10,10,12, 8, 10)	A				0.00	0.00
		B				0.00	0.00
		C				-0.10	-0.10
		D				0.00	0.00
	Total Common but not fixed (10,10,12, 8, 10)					-0.03	-0.03
	U (9.9-10.1; 9.9-10.1; 7.9 -8.1; 5-15; 14-16)	A		-1.98			-1.98
		B		0.00			0.00
		C		-0.61			-0.61
		D		0.07			0.07
	Total U (9.9-10.1; 9.9-10.1; 7.9 -8.1; 5-15; 14-16)			-0.63			-0.63
Total 29/03/2011			0.22	-0.63	0.26	0.11	0.06
Total general			0.22	-0.63	0.26	0.11	0.06

Figure 6. Auction results

From the financial point of view, and just using descriptive statistics, it looks like "common" values call for lower profits due to the increased competition and that First Price and Dutch obtain lower prices (Kagel and Levin 1986; Turocy et al. 2007), and English auctions might rise the price more (Levin et al. 1996). More experiments are however necessary to perform a more robust inferential study and confirm these results.

Discussion

Regarding teaching, the experiments showed the potential to study concepts like:

- The importance of perfect information as provided by the common values
- The possibility of monopoly, by raising the bids and not earning profits
- The entry barriers: just by assigning low values to the same player throughout one experiment.
- The technological restrictions and advantages: some computers have better connections to the internet than others.

In terms of research, the use of the simulator demonstrated the possibility of designing a full, consistent set of experiments, whose results could shed new light on how to set a market or submit bids. Besides, the experiments could resemble the real system; role playing case studies (Myron 1971; Holt 1996; Asker et al. 2004) should be set accordingly.

Finally, *econport* has proved to be a simple tool to learn easy general concepts about auctions but somewhat rigid up to our knowledge when:

- Setting rules across periods, since the values must be set before hand.
- Analysing and comparing the results across experiments, since the values must be copy-pasted into the spreadsheet.

CONCLUSIONS

It is feasible to use *econport* to learn about capacity auctions, which will be used ever more across Europe and specifically in Spain.

The experimental simulator has been tested in a business with success. However, it appears the need to develop more "realistic" scenarios to be used as the basis for the experiments.

There also exists the possibility of performing on-line sessions. *econport* should however be integrated with other on-line tools to facilitate the communication between bidders and the auctioneer. These on-line groups might be bigger and would increase the possibility of repetitive experimentation to help in teaching and research.

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