



## **PhD Thesis in Law and Economics – XXIII cycle**

Abstract

Tutor: Prof.ssa Daniela Di Cagno

PhD Candidate: Matteo Mazzotta

## **Auction in the electricity market: agent-based models vs experimental economics**

After the electricity market deregulation processes in the 90s in industrialized countries, vertically integrated monopolies began markets with mainly two different clearing mechanisms: discriminatory price auction (DPA) e la uniform price auction (UPA). In both mechanisms generators submit their bids (couples of quantity and price) and then a market clearer clears the market matching supply and demand. The difference between the two systems is that in DPA every winner generators are paid the prices they bade ("pay as bid"), while in UPA winner generators will be paid the same unique system marginal price, the equilibrium price between demand and supply.

The auction design impacts on market prices, volatility and market power because it influences the way generators bid. In UPA, a rational generator will bid a price equal to her marginal cost in order to maximize the ex ante probability to win the auction. In DPA, the best strategy is to bid a price equal to the forecasted equilibrium price, regardless of the marginal cost level (and, therefore, the production technology).

The supply function in UPA is steeper than supply function in DPA. Real data don't fit mainstream economic theory. In fact, the theoretical framework is really tough because auctions are repeated in time (usually one hour haul) and generators can reach collusive equilibria. In this case, the study of prices, volatility and market power requires more robust analytical tool. This is the main reason why alternative approaches are suggested to enhance the forecasting powerfulness available to the legislator in the market design activity for electricity market. These alternative tools have to cope with complexity. Two approaches are presented in this thesis: Agent-based models (ABM) and Experimental economics (EE). ABM are computer simulation of software agents who interact each other learning from the experience (through reinforcement learning algorithms) the strategies that maximize their payoff. EE studies economic phenomena through human subjects experiments.

Both approaches analyzed the discussion UPA vs DPA. In the thesis I make a comparison between ABM and EE methodologies. ABM are cheaper than human subject experiments because they don't require any incentive system, which is the main cost issue in human subject experiments. Measuring the learning rate in human subject is difficult and also monitoring of system initial condition is not always possible, while in ABM the learning is driven by algorithms and the set up of initial conditions is completely reliable. In addition, in human subject experiments we observe phenomena such as the herding or inconsistent set of preferences: if such phenomena on one side don't enable to follow a perfectly rational strategy, on the other side bring the experimental setting closer to reality.

In the last part of the thesis, there are some normative statements on the discussion UPA vs DPA. If the policy objective is low prices, the legislator should opt for UPA. Nevertheless, volatility is an important issue, mainly because electricity market is intrinsically volatile. Therefore, if the prevailing choice is to lower the volatility, legislator needs to choose DPA.

In oligopolistic market, UPA and DPA come out to be the same: ABM agents and human subjects, in fact, learn very quickly how to bid in order to get collusive equilibria.