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Handling parameters in multi-round Auction: An example from Tunisia irrigation auction

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Abstract— **Climate variability in Tunisia (a marked difference between the availability of water in the North West and the use of water for irrigation in the North East of Tunisia) makes water resource both scarce and unequally distributed in time and space. This issue led to search for mechanism that make water management more efficient and that ensure a good distribution of this resource in all areas of the country by encouraging some farmers, who do not use all their allocated water (representing as permits), to sell them to the State. The State subsequently transfers them to other exploiting who need, to ensure that everyone benefits, using a multi-round auction as a market mechanism to share these permits. In response, we proposed to conduct a laboratory experiment, to test a variety of auction treatments taking irrigated perimeter of Beja as example. This paper reports the results of this experiment and how they were interpreted and used by the policy maker.**

Keywords— **climate, experiment, auction, irrigation, water, price**

I. INTRODUCTION

Water, that's life and this, is not a "commodity like others." Water was implicitly treated as a free good, or at least, not a limiting factor in economic development and agricultural pursuits.

Indeed in Tunisia, until now the water resource was available and accessible, either directly or through additional mobilization programs of supply increase. Today this is no longer possible, firstly Tunisia, because of its location between the Mediterranean and the Sahara, is *an arid country* on the majority of its territory. There is a marked difference between the availability and use of water among the North West and North East of Tunisia: in North West (example Beja city), the flow of rainfall and rivers are higher and more evenly distributed. However, in North East (example Nabeul city), although rainfall is lower, there was held in a large development of irrigation.

This difference, combined with the variability of the Mediterranean climate, makes water resource *unequally distributed in time and space.*

For more efficient management of irrigation water and in order to have a good distribution of this resource in all compartments of the country; the state should determines in a current year the actual water requirement of some farmers from the North East who had not sufficient water for irrigation, and then encourages farmers from the North West who do not use all their allocated water permits to sell them to the state. So that this latter transfer them to the East region which is required, using an auction as a market mechanism to share these permits.

II. METHOD

A. Auction purpose

Economically, our goal is to ensure a good distribution of water in all areas of the country and to satisfy the needs of all farmers from water. To achieve this goal, and for more efficient water management, some farmers from the West region who do not use all their allocated water (representing the number of acres) can sell them to the state. The State subsequently transfers them to other operators from the East who need, to ensure that everyone enjoys and then to better distribute this resource in all areas of the country, using auction as a market mechanism to share these permits at a price determined by the interplay of the market.

B. Auction design

The water use permit auction involves a single, budget-constrained, buyer facing many sellers. The value of irrigation to farmers in this region (Beja) contains on the one hand private value since differences in permit size, soil quality, and location created variations in productivities of irrigated land.

On the other hand, it contains common information as farmers in Beja region use irrigation for one or more of three major crops (cereal, arboriculture, and vegetable culture).

According to Ronald G. Cummings, Charles A. Holt and Susan K. Laury (2002) *"The auction may be desirable in relation to the administrative procedure, as farmers show (at least indirectly) their intentions to sell their water rights for a season".*

A multi-round auction will be used as a market mechanism to share these permits at a price determined by interactions in this market. If, for example, a simple sealed offer auction is conducted and the submitted offers are extremely high, very few offers would be accepted. So allowing for revision gives farmers the chance to acquire information about other's bidding behavior, to think about the situation, then to revise their offers, and thus to increase the amount of resources committed to bidding in stages.

Because experimental studies indicated that one stage sealed bid auction is not efficient (Kagel and Levin (1993) and Kagel (1995), based on findings by Ariely, Ockenfels and Roth (forthcoming)), "*there is a reason to believe that allowing bidders to adjust their bids over multiple stages increases observed efficiency*".

In this auction, subjects did not know how many revision rounds would be conducted. Then no restrictions on the revisions are placed.

In addition, bidders' revenues from an auction depend on their bidding strategies, which in turn depend on a variety of auction parameters (budget constrain, acreage target, number of participant…), because this latter (parameters) influences strategies especially in this multi-round auction.

So modifying the (se) parameter (s) during the auction has an impact on bidder's behavior, so on strategies made by these subjects, and thus on bidder's revenue. Then, varying parameters in multi-round auctions is my central feature.

How bidders will react facing the manipulation of parameters?

C. Overview of the literature

Previous work in the economics has addressed this problem but in some different aspects:

1) Fixed budget constraint:

Ronald G. Cummings, Charles A. Holt, and Susan K. Laury (2002) treated this issue, by fixing the budget constraint during the auction, and allowed participants only to revise their offers at each round, to see the benefit of this latter on offer's distribution using a series of laboratory and field experiments. By fixing and announcing the budget constraint, allowing revision, and observing what the outcome would have been in each round, they approximated their analysis, which showed that even though the distribution of offers did not change substantially, this later allowed the policy maker to obtain a greater number of acres at a lower price, and at late rounds of the auction. As summarize, we can say that Ronald G. Cummings, Charles A. Holt, and Susan K. Laury (2002), considered this problem by fixing parameters during auctions, and not manipulate them.

2) Reserve prices:

Daniel R. Vincent (1989) studied the problem of handling the reserve price, using an auction in which a reservation price is kept secret, compared to one in which it is announced, motivated by the goal of finding a policy which yields the seller to the highest expected revenue.

Using a second reserve price auction, they found that the policy of keeping private reserve prices enhances the revenue of the seller, because it encourages the participation of bidders (greater number of bidders), so increases the price paid to the object. However the announcement of the reserve price occurs a winning at this price, if the object is not worth purchasing. As summarize, Daniel R. Vincent (1989) treated this issue either by announced the reserve price or by keeping it secret, but he didn't try to handle this parameter in multi-round auction.

3) Environmental projects:

Timothy N. Cason, Charlotte Duke and Lata Gangadharan (2002), treated the environmental problem to achieve the goal of reducing pollution. To do this, the regulator has encouraged farmers to change their ways of land use using two auctions, one in which environmental projects related to change of use are kept secret, compared to one in which they were announced, motivated by the aim of finding a policy that yield regulator to the best strategy for reducing pollution.

Using a multi round English auction, they found that the policy of keeping private environmental projects improves the efficiency of the regulation as sellers know only the costs of changing the use of land and not the profits generated by these projects. However the announcement of the environmental projects decreases the performance of the market: farmers bid very high bids for projects of high quality (which increases their profits) and so very few bids will be accepted.

As summarize, Timothy N. Cason, Charlotte Duke and Lata Gangadharan (2002), treated this issue either by announced the environmental projects or by keeping it secret, but he didn't try to handle this parameter in the same multi-round auction.

To conduct our auction, some rules announced by the auctioneer need to be adopted, these rules specify how bidding will be conducted, and how bidding will determine who wins what and who pays whom.

D. Auction rules

First, a multi-unit auction is considered, since most farmers use irrigation for one or more of three major crops, (cereal, arboriculture, and vegetable culture). It means that farmers have more than one irrigation permit that one of them may hold irrigation permits for land that is used to grow different crops, and therefore has different values, depending on which crop he plants. The value of irrigation contains both common value and the private one. The common value is the

common information about the value of irrigation of other farmers, while private value has different values depending on the type of crops, size of the perimeter, soil quality…

Second, there are many potential "sellers" (farmers) and only one "buyer" (the policy maker), in which the policy maker fixes and announces the target number of acres (permits) that he needs to buy from farmers for economic purpose, and also specifies the budget constraint by which he will purchase this target, but he does not announce it.

Then, farmers make offers to sell their additional amount of water that they do not need to a target amount, by submitting the price at which they would be willing to sell their permits. These bids may be accepted or rejected by the policy maker.

Finally, because this type of auction had never been conducted in this region, it is important that rules (as price rules) and procedures be clear, easy understood, and also easy to implement. In particular, it was important that all farmers understand how their payment would be determined by their offer prices.

1) Price rules:

A uniform-price versus a discriminatory price

Previous research as "*Hailu and Thoyer, 2005a"* has shown that different payment formats influence bidding behaviors, so it is important to understand the possible payment rules that can be used in auctions:

- Discriminatory (first-price) sealed-bid tender where each bidder is paid an amount equal to his or her actual winning bid, or
- Uniform-price sealed-bid tender, where all successful bidders are paid an amount equal to the highest accepted offer price or, alternatively, the lowest rejected offer price.

According to UweLatacz-Lohmann and Steven Schilizzi, (2005), *"On balance, the discriminatory payment format appears to be the more appropriate payment rule for budgetary auctions because it can yield greater budgetary cost effectiveness".*

So a discriminatory auction will be considered in this auction

Reserve Price

A reserve price strategy is considered as an upper limit on the amount that subject is willing to pay for a unit of a good being traded. It avoids the risk of being excluded from an auction by bidding too high.

According to UweLatacz-Lohmann and Steven Schilizzi, (2005), *"reserve prices are less important where there is a strict budget constrain".*

In this paper the budget constraint will not be announced by the experimenter, so we must consider a reserve price in this auction to avoid the risk of bidding too high.

A tie breaking rule

The possibility can exist that a tie could occur in an auction. In this case, we should randomly choose among offers to stay within the fixed budget constrain.

2) Hypothesis

Taking the positive effect of having multiple stages, and in order to reach the policy maker's goal, we hypothesize that;

- "Increasing the budget constraint between sessions leads to an overbidding for high values, and thus to an increase in seller's revenue (seller's goal)".
- "Decreasing the budget constraint between sessions leads the experimenter to obtain a fixed target number at lower price and at later round (buyer's goal)".

To test this hypothesis, we proposed to conduct a laboratory experiment, which ensures the achievement of these objectives.

III. Implementing the irrigation auction in Laboratory Experiments

A. Laboratory implementation

Subjects were mostly students in the Laboratory, who will be in the position of a farmer who has two "permits" to irrigate acres of land, in which they make offers to sell some of these permits for a given amount. For each permit, subject was affected the per acre value.

The most acreage in this region (Beja) is in cereal, arboriculture, and vegetable culture. We are in the position of the government, in which we are charged to control water use, so we are charged to fix and to announce a "target number of acres" that we wish to buy from participants, also we have a budget constraint (not public announced) by which we will purchase this target, and that we would accept as many offers as possible until we reached this amount within this budget.

We will use a discriminatory auction, because a one own-shot sealed offer auction would be easier to implement, to buy the (se) permit(s) back from these subjects in order to better distribute the water among areas. In the other hand, discriminatory auction is less prone to distortion auction efficiency.

Subjects are firstly isolated from one another during the first round. Then they will be allowed to communicate and to feel free during the other rounds. Also, because we expected many of the subjects to know one another, we will place no restrictions on friends participating together in this experiment.

All subjects began by submitting their offers, these latter were ranked from low to high, in which the lowest priced offers were "provisionally" accepted and then, we can determine how many permits we would purchase within my budget constraint.
The provisional winners were announced by simply announcing the cutoff price, means the maximum price at which offers was accepted. (All offers at or below this price were provisionally accepted).

After the announcement of provisional winners, all subjects were turn in a revised offer. If no new offer was turned in, the previous offer stood. The new offers were then ranked, and new provisional winners were announced. This process continued until either reaching the target number of acres, or until no one wished to submit a revised offer. So the provisional acceptances from the most recently round became final acceptances (which determine the final maximum accepted offer).Subjects did not know in advance which would be the final offer round.

Decisions are made over a series of rounds (All offers below the maximum accepted price will definitely be accepted), and then the subject would have sold the (se) permit(s).
So if:

- We discover that the amount of acres that we have purchased is reached under my fixed budget, then we will try to modify the budget constrain (decrease it) and to treat it as treatment variable (either we announce the modification of the budget in one session or we keep it secret in another one), then see how the competitive price change between sessions and the best strategy that allow to reach the fixed acreage number at lower price.

- The amount of acres that we have purchased is less than my fixed budget, we will try to increase it and to treat it as treatment variable (either we announce the modification of the budget in one session or we keep it secret in another one), in order to achieve the fixed acreage number.

Earnings are reported at the end of round. For each permit, the subject was told the (per-acre) value. If the permit was sold, the subject would earn the negotiated per-acre price (sales price) multiplied by the number of acres covered by the permit.
But, if the permit was not sold, the subject would earn this per-acre value, multiplied by the number of acres covered by the permit.

B. Laboratory experiments

This section describes the treatments that I proposed to test in the lab. Overall, 08 subjects: PhD students in economics sciences from faculty of Economic Sciences and Management of Sousse Tunisia (FSEGS) and higher institute of management of Sousse (ISGS).

The experiment took place in Sousse between FSEG and ISG in a computer room where participants were isolated from each other. The software Z TREE (Zurich Toolbox) enabled the programming and the conduct of the experience. Subjects participated in 3 auctions held during 3 sessions in November 2015 (a discriminatory price auction with revisions, which is equal to their own accepted bids), so a single auction in each session, varying treatment between sessions (shown below on table 1).

TABLE 1: TREATMENTS

Treatment	Sessions	place	Characteristic
REF	REF_1	Isg_Sousse	Asymmetry of information on the budget
SECRET	SECRET_2	Fseg_Sousse	Keep secret the modification of the budget
ANNONCE	ANNONCE_3	Fseg_Sousse	Announce the modification of the budget

Each session lasted for 30 minutes and contains 6 rounds. Participants made their trade in Tunisian dinars and were paid at the end of the experiment.

To explain the procedures of the auction and how earnings were calculated, we will use extensive instructions. These instructions are read to all participants at the beginning of experience.
Participants should at the beginning well understand these instructions and work through practice auctions, because they will be asked to calculate their earnings.

In the first asymmetry auction and after the fixed acreage was announced (equal to 7000 acres in this experiment), subjects submitted the price that they would be willing to sell their permits. Offers were publicly recorded and ranked and the lowest-priced offers were accepted until the budget constraint had been expended. Those participants whose offers were accepted were paid the discriminative price, and the item was taken from them.
The others whose offers were rejected received no money but were still able to use their permit.

So if we discover that the amount of acres that we have purchased is reached under our fixed budget, then we will try to decrease the budget in order to obtain our target acres at lower price and to treat it as treatment variable (either we announce the modification of the budget in one session or we keep it secret in another one).

And because handling this parameter has an effect on bidding behaviors and then on offers distribution, we proposed to conduct a second auction in which we keep secret the modification on the budget (second treatment), and another one in which we announce that there is some modification (third treatment), to focus on how subjects will react at each session (at each auction) and during rounds, and to see how the competitive price change between sessions and the best strategy that allow me to reach the fixed acreage number at lower price.

IV. Results and discussions

Table 3 and table 4 list the highest accepted offer price, the cumulative number of acres, and the cumulative cost of all accepted offers during each round.

In the second auction when the experimenter chooses to keep handling the budget secret, bidders continued to submit their offers. Across revisions rounds, when communication is allowed between subjects, table 3 shows that the highest accepted offer price declined from 140 dinars in round 1 to 125 dinars in round 5 and then increased a little bit to 128 dinars in round 6.

In the first round, we would have accepted a total of 7200 acres at a cost of 753 500 dinars.

In round 5, we would have accepted a total of 7000 acres at a cost of 834 800 dinars.

However, because of our announced highest accepted offer price, a bidder can then observe that this latter decrease over rounds, so he can guess that there is some manipulation which encourages him to over bid at later round, wishing that his bid will be accepted and that his earning will be increased. This result is shown in round 6 when the highest accepted offer price is increased to reach 128 dinars. Doing this allowed the sellers to increase their revenue.

The number in bold shows the best outcome that we have attained in this auction

In the third auction and by announcing that the budget is modified (decreased). Across revisions rounds, table 4 shows that the highest accepted offer price declined from 130 dinars in round 1 to 120 dinars in round 5.

In the first round, we would have accepted a total of 7100 acres at a cost of 825 100 dinars.

By announcing the decrease of the budget, subjects tend to submit higher bids in the second round in order to increase their earnings (the cost in second round is equal to 893 200 dinars), but when they discover that their offers were rejected in the third round, they tend to fall it again to avoid being excluded from the market. This result is shown in round 3 and round 4 (the cost fell from 873 400 dinars to 830 750 dinars).

Doing so, allowed the experimenter to attain the fixed acreage (which is equal to 7000 acres) at lower price and at later round. It is also confirmed in round 5 when we have accepted a total of 7050 acres at a cost of 823 350 dinars.

The number in bold shows the best outcome that we have attained in this auction

Using any of the two treatments, the best outcome of the two auctions has been attained in Round 5 which called the improved final-round outcome (shown on Fig.1). Results prove the benefit of revised offers.

V. Conclusion and Policy Implications

In this paper, our motivation were to set up an "auction", that treat the problem of handling parameters (on asymmetric and on symmetric information) in a multi-round auction with multiple bidders, in order to see how bidders would behave facing some modification in parameters, and to search for the best strategy that leads bidders to the highest expected revenue.

To achieve these objectives, we have considered the irrigation in Beja and we have proposed to conduct a laboratory experiment (which enabled us to make recommendations about rules), varying treatments at each auction, to discover the manner at which the bidder would behave after each bid revision round.

We have evaluated this alternative auction mechanism to test some parameters (a budget constrains as a treatment variable) in the laboratory using students as auction participants and it was considered a success.

Our future research were to consider Beja irrigation as a field experiment, to test the same parameters using farmers as auction participants and then compared farmers' bidding behavior results with our experimental results.

References

[1] J. Kagel and D. Levin, "Independent Private Value Auctions: Bidder Behavior in First-, Second- and Third Price Auctions with Varying Numbers of Bidders", *Economic Journal*, vol.103, pp.868-879, 1993.

[2] Ronald G. Cummings, Charles A. Holt, and Susan K. Laury, "Using Laboratory Experiments for Policy Making: An Example from the Georgia Irrigation Reduction Auction", *Journal of Policy Analysis and Modeling*, vol.23, pp. 342-363, 2004.

[3] Ariely, D., A. Ockenfels, and A. E. Roth, "An Experimental Analysis of Ending Rules in Internet Auctions",*Rand Journal of Economics*, vol.36, pp. 891-908, 2005.

[4] Dasgupta, P. and E. Maskin, "Efficient Auctions",*Quarterly Journal of Economics*, vol.115, pp. 341- 389, 2000.

[5] Roth, Alvin E. and Ockenfels, Axel, "Last Minute Bidding and the Rules for Ending Second-Price Auctions: Theory and Evidence from a Natural Experiment on the Internet", *National Bureau of Economic Research (Cambridge, MA)*, 2000, Working Paper No. 7729.

[6] R Préget, S Thoyer, "Does the competition structure impact the performance of multi-unit auctions? An experimental investigation", *Recherches économiques de Louvain*, vol.80, pp. 85-109, 2014.

[7] Lawrence M. Ausubel, "An Efficient Ascending- Bid Auction for Multiple Object", *The American Economic Review*, Vol.94, pp. 1452-1475, 2004.

[8] Ausubel, Lawrence M. and Peter Cramton, "Demand Reduction and Inefficiency in Multi-Unit Auctions," *Discussion Paper, University of Maryland*, 1998.

[9] Daniel R. Vincent, "Bidding of the wall: why reserve prices are kept secret" *Discussion Paper Management Northwestern University*, 1989, paper No. 838.

[10] Bjornlund, Henning, and Jennifer McKay, "Aspects of Water Markets for Developing Countries: Experiences from Australia, Chile, and the US." *Environment and Development Economics*, vol.7, pp. 769–795, 2002.

[11] Stéphane Robin, "L'efficacité des marchés : quelques enseignements des expériences en laboratoire", *Idées économiques et sociales*, vol.161, pp.40-47, 2010.

[12] Douadia Bougherara and Virginie Piguet, " Marchés avec coûts d'information sur la qualité des biens : une application aux produits écolabellisés", *Economie et prevision*, vol.182, pp. 77-96, 2008.

SUPPLEMENTARY DATA

TABLE 2 : RESULTS FROM THE NOVEMBER, 2015 IRRIGATION AUCTION

Treatment 1 : asymmetric information on the budget constraint
With a fixed target number = 7000 acres

Offer Round	1	2	3	**4**	**5**	6
Cumulative Acres	4950	6500	6450	6100	**6450**	6350
Cumulative Cost	631,200	888,350	890,550	829,350	**853,050**	852,450
Highest offer price	140	140	139	138	**137**	138

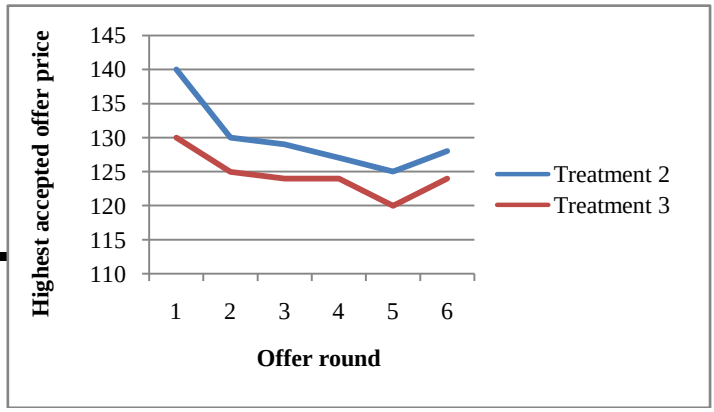

Fig. 1 A highest accepted offer price over rounds

TABLE 3 : RESULTS FROM THE NOVEMBER, 2015 IRRIGATION AUCTION

Treatment 2 : keep handling the budget secret
With a fixed target number = 7000 acres

Offer Round	1	2	3	**4**	**5**	6
Cumulative Acres	7200	7400	7400	7250	**7000**	7250
Cumulative Cost	753,500	843,000	856,150	843,300	**834,800**	850,200
Highest offer price	140	130	129	127	**125**	128

TABLE 4 : RESULTS FROM THE NOVEMBER, 2015 IRRIGATION AUCTION

Treatment 3 : announcing that the budget is decreased
With a fixed target number = 7000 acres

Offer Round	1	2	3	4	**5**	**6**
Cumulative Acres	7100	7300	7300	7050	**7050**	7300
Cumulative Cost	825,100	893,200	873,400	830,750	**823,350**	873,400
Highest offer price	130	125	124	124	**120**	124