Reserve prices in online auctions[1]

Susana Cabrera Yeto[2], Rosario Gómez[3], Nadège Marchand[4]

January 2007

Abstract: In this paper, we investigate the effect of minimum bids in electronic auctions. The extensive use of auctions in electronic markets is explained by efficiency. In practice, auction houses and online auctioneers allow sellers to specify a number of different parameters when listing an item for auction. Among these are the level of the opening bid and the amount of a "reserve price" below which the seller will not sell the item. On the one hand, the reserve price restores the seller control on the auction results. On the other hand, it eliminates all the potential buyers whose offer would have been lower than this level. If all buyers' valuations are below the reserve price, the item isn't attributed. The introduction of reservation price in the auction introduces dramatic changes in the auctioneer behaviors. Our paper analyzes the effects of public and secret reserve prices, and the selection of reserve prices itself, in English auctions using laboratory experiments. In our experimental design, the seller decides to sell the item at a minimum price (Riley and Samuelson 1981.) which is either communicated to potential buyers (public reserve price) or not (secret reserve price). Then, the three bidders bid in an auction for an item. The introduction of a reserve price reduces the efficiency level of the auction, by generating conflicts, as well as the expected revenues of the seller and the buyers.

[1] We wish to thank Marie-Claire Villeval, Laurent Flochel for their useful comments. We also thank Rudy Sabonnadiere for skillful research assistance. Financial support from the CNRS/CGP and PAI/Picasso program is gratefully acknowledged (this paper was part of the project "Société de l'Information"). Any errors are our own.

[2] Departamento de Estructura Económica, Universidad de Málaga, El Ejidos/n. email : yeto@uma.es

[3] Departamento de Teoría e Historia Económica, Universidad de Málaga, El Ejidos/n. email : rosgomez@uma.es

[4] GATE, 93, chemin des Mouilles, B. P. 167, 69130 Ecully. Email : marchand@gate.cnrs.fr

1. Introduction

Online auctions are one of the most successful forms of electronic commerce. Web sites as eBay counts some 3.8 million registered members to take part in auctions.[5] Online auctions are one of the leading innovations in electronic market. In practice, online auctioneers allow some freedom to the sellers in choosing a number of parameters when listing an item for auction (see the seller guide of Yahoo, QXL, eBay.) Thus, sellers determine important elements of the auction rules, which dramatically influence the result. Among these are the level of the opening bid and the amount of a "reserve price" below which the seller will not sell the item. Both options restore the control of the seller on the occurrence of a sell. Indeed, the seller decides the minimum price he wants to receive for the item, which eliminates all the potential buyers whose offer would have been lower than this level. If the buyers' valuations of the object are below the reserve price, the item is not sold.

Note that the extensive use of auctions in electronic markets is explained by efficiency. In an auction without reserve price, the good is always attributed to a buyer. As a consequent, auction generates higher expected revenue than other bilateral sell mechanism such as negotiations in which a conflict is likely (Bulow, Klemperer, 1996.) As emphasis by the theoretical literature (see Klemperer 1999 for a survey) and online seller guide, the determination of the reservation price is a critical decision.

Despite the widespread use of reserve prices in auction, there is, to the best of our knowledge, few empirical works on that topic. According to Bajari and Hortaçsu (2000), the minimum bid or a public reserve price is one of the most important determinants of entry in auction. Public reserve price censors the distribution of bidder valuations by discouraging some bibbers. Katkar, Lucking-Reiley (2000) and Lucking-Reiley (2000) run field experiments on secret vs. public reserve price effects on bids by selling pokémon card and magic card on the eBay. Their main conclusion is that secret reserve prices reduce significantly the probability of sell and, therefore, the earning of the seller. Nevertheless, those studies disregard important factors, which may influence behaviours such as buyers' private valuation of the item, risk aversion.

Laboratory experiments have been extensively used to investigate a wide variety of hypotheses from auction theory (see Kagel, J.H, 1995 for a survey), but, to the best of our knowledge,

[5] See The economist, July 22, 1999, "The Heyday of Auction".

effects of a secret or public reserve price are not among the topics covered, even when it is a usual practice of auction houses.

Institution design: Roth details matters.

Our paper analyzes the effects of public and secret reserve prices in English auctions using laboratory experiments. According to Riley and Samuelson (1981), the reserve price value is independent of the number of bibbers. Indeed, we form groups of four participants composed of three buyers and a seller. In our experimental design, three bidders bid in an auction for an item, which have a random value at the moment the seller decides to sell the item at a minimum price. How do bidders value items they are bidding on? One answer to this question is to say that each bidder indexed i gets utility v_i from winning the item. If bidder i knows v_i but not the v's of other bidders, the valuation of the item is private. This situation makes sense if the bidder is buying the item without intention to resale it. In the remaining, we assume that buyers have private and independent valuations of the item, such that, they can't resale it.

The reserve price is either public (treatment 1) or secret, the bidders bid without knowing the minimum price accepted by the seller (treatment 2.)

The introduction of a reserve price reduces the efficiency level of the auction, by generating conflicts, as well as the expected revenues of the seller and the buyers. Sellers select the reserve prices optimally. Sellers' behaviour is affected by the introduction of a reserve price; we note an important number of overbidding behaviours. We obtain a significant treatment effects due to the information on the reserve price. Bidders are significantly less aggressive when they know the value of the reserve price. Therefore, the probability to sell the good in auction with reserve price is significantly higher for secret reserve price.

The remainder of the paper is organized as follows. Section 2 presents the game theoretical analysis of reserve price auction derived from auction theory. This analysis provides the basis to understand the buyers' and seller's behaviour. Section 3 introduces the experimental design and describes the theoretical hypothesis. Section 4 analyzes the experimental data and discusses the results. Finally, section concludes.

2. Theoretical background

Consider a single seller of an indivisible good with reservation value v_0, who faces *n* risk-neutral potential buyers. Each buyer *i* holds a reservation value v_i, with *i*=1, 2, .., *n* and $v_i \in \left[\underline{v}, \bar{v}\right]$. In the following, we assume that private valuations of parties are identically distributed and independently drawn from the uniform distribution with $F(\underline{v}) = 0$, $F(\bar{v}) = 1$. Note that the analysis for common distribution, *F(v)*, is presented in the appendix 6.1.

In the English auction, the good is awarded to the buyer who makes the final and highest bid. The buyer placing the highest valuation on the good pays approximately the maximum of the reservation values of the other *n*-1 buyers. As Vickrey noted, this is equivalent to a second-price sealed-bid auction in which each buyer submits a bid and the high bidder pays the second highest rather than the highest bid.[6] The outcomes of the English and second-price auctions satisfy a strong criterion of equilibrium: they are dominant equilibria; that is, each bidder has a well-defined best bid regardless of how high he believes his rivals will bid. In a second-price auction, the dominant strategy is to bid true valuation; in the English auction, the dominant strategy is to remain in the bidding until the price reaches the bidder's own valuation. Indeed, these dominant strategies are independent of buyers' risk posture.

The seller can either, take part to a simple auction (subsection 2.1) or, determine a reserve price (subsection 2.2). In former case, the buyer who submits the highest bid win the auction and a sell always occurs. In the latter situation, the seller determined a reserve price, which corresponds to the smallest bid he will accept. If all bids are lower than the reserve price of the seller, the item isn't sold. The next subsections present the equilibrium behaviours of the buyers and sellers as well as their expected revenues in both cases.

[6] In general, with the assumptions that underlie the model, any mechanism which always gives the good to the highest-value bidder in equilibrium, and a bidder with the lowest feasible valuation has no chance of any surplus, yield the same expected payment by each bidder and the same expected revenue for the seller. This is the *Revenue Equivalence Theorem.* See, for example, Vickrey (1961). However, *equivalent* auctions to the English auction and to the second-price sealed-bid auction do not share the feature of dominant equilibrium necessarily.

2.1 Auctions with no reserve price

Given that each bidder will announce his true valuation in the second-price sealed-bid auction.[7] An individual with valuation v will win with probability $F^{n-1}(v)$, which is the probability that all others will have valuations and bids below v. The expected payment to this bidder is:[8]

$$P(v) = \frac{(n-1)v + \underline{v}}{n} F(v)^{n-1}$$

So the expected payoff to a buyer with value v to making a bid is:

$$\pi^e = \frac{F(v)^n (\bar{v} - \underline{v})}{n}.$$

The expected payment by the buyer with value v, contingent on winning, will be:[9]

$$H(v) = \frac{(n-1)v + \underline{v}}{n}$$

In the case of the uniform distribution, the expected k^{th} highest value among n values independently drawn from the distribution on $\lfloor \underline{v}; \bar{v} \rfloor$ is:[10]

$$\underline{v} + \left(\frac{n+1-k}{n+1} \right) (\bar{v} - \underline{v})$$

In a second-price (or ascending) auction, the seller's expected revenue is noted Λ with:[11]

$$\Lambda = \underline{v} + \frac{n-1}{n+1} (\bar{v} - \underline{v})$$

That is the expected second-highest valuation of the n valuations.[12] Note that, a bidder with a lower valuation than the seller's valuation can purchase the item. In this case, the outcome is not efficient. Note also that the expected revenue of the seller, Λ, is a strictly increasing function of the number of buyers, n. Thus, the more bidders there are, the larger is the seller's expected revenue.

2.2 Reserve prices

If the seller announces a reserve price R, his expected revenue increases until:

---

[7] In an ascending auction, each bidder will remain in the bidding until the price reaches his own valuation.
[8] The expected payment corresponds to the expected price paid to the seller by this buyer.
[9] The general expressions of $P(v)$ and $H(v)$ can be found, for example, in Bulow and Roberts (1989).
[10] See, for example, Klemperer (1999).
[11] A proof of the general expression of Λ is given in Riley and Samuelson (1981).
[12] Note that in the case of the uniform distribution Λ=$H(v)$ if $v = \underline{v} + \frac{n}{n+1}(\bar{v} - \underline{v})$; that is, if the winner's valuation is the highest expected valuation.

$$\Omega = \underline{v} + \frac{n-1}{n+1}(\bar{v} - \underline{v}) + \frac{(R-\underline{v})^n \left[\bar{v}(n+1) - 2(Rn + \underline{v})\right]}{(n+1)(\bar{v} - \underline{v})^n}$$

Note that if no reserve price was announced, or $\underline{v}$ is greater than the reserve price, *R*, then the expected revenue equals Ω.

Then, the reserve price, which maximizes the expected revenue of the seller, is:[13]

$$R^* = \frac{v_0 + \bar{v}}{2}$$

Note that this reserve price, R^*, is independent of the number of buyers. Furthermore, if the reserve price is higher or equals to the seller private valuation, $R^* \geq v_0$, the item is sold and a bidder with a valuation greater than the seller's valuation purchased the item. Thus, the seller receives a positive payoff. Indeed, the equilibrium reserve price, R^*, is increasing in his private valuation, v_0, and the highest value of the buyers' support distribution, $\bar{v}$.

Proposition: *Whether the optimal reserve price selected by the seller is announced publicly before bidding or not, does no affect either the seller's expected revenue or bids.*

As in English auctions and second-price auctions, the strategy of bidding one's true valuation is a dominant strategy. The seller cannot influence bids by concealing his reserve price. Then, the optimal silent reserve price is the same as the optimal announced reserve price, and the expected seller revenue is identical.[14]

Substituting in Ω for equilibrium reserve price, R^*, the total expected return to the seller is noted Γ and equals:

$$\Gamma = v_0 F^n(R^*) + \Omega = \underline{v} + \frac{n-1}{n+1}(\bar{v} - \underline{v}) + \frac{(\bar{v} + v_0 - 2\underline{v})^{n+1}}{2^n (n+1)(\bar{v} - \underline{v})^n}$$

The term $v_0 F^n(R^*)$ indicates that if no sell occurs (i.e. all bidders have values below the reserve price) then, the seller keeps the item and receives his own valuation.

[13] See Riley and Samuelson (1981).

[14] As Riley and Samuelson (1981) note, the argument is more complex in the case of Dutch auctions and first-price sealed-bid auctions, but once again it can be shown that there is no advantage in using a silent reserve price. However, the argument does not apply out of the independent-private-values-model. Vincent (1995) shows that in a common-value auction, a silent reserve price increases participation of buyers, which may increase the expected revenue of the seller.

The analysis of the differences between the expected revenues of the seller in auctions with and without optimal reserve price, Γ-Λ, allows us to compare the two auction mechanisms from the seller's point of view. The sign of the derivative of Γ-Λ with respect to n is negative. Hence, the more bidders there are, the less is the difference between the seller's expected revenue with and without an optimal reserve price. Indeed, this difference is increasing in the seller private valuation, v_0.

When the seller optimally sets a binding reserve price, an inefficient outcome may occur. If all bidders' valuations are below the optimal reserve price, R^*, the good is not sell. In this case, the seller may keep the good despite the presence of some bidders with a higher valuation than the seller's own valuation.

The introduction of an optimal reserve price induces inefficiency in auction. Indeed, the second-price sealed-bid and English auctions are not optimal selling mechanism if they are supplemented by the optimally set reserve price.[15] Then, the seller could, for example, have several rounds of bidding, or charge bidders entry fees, or allow only a limited time for the submission of bids. None of these more complicated strategies would increase the expected price.[16]

However, while this result is theoretically appealing, we have no idea about whether it characterizes bidding behaviours in real auctions. Therefore, our main concern is now to test the empirical properties of reserve prices in auction and examine whether the behaviour of real participants complies with the theory. The next section presents the experimental procedures and theoretical predictions before focusing on the experimental results.

3. Experimental design and theoretical predictions

Section 3.1 explains the parameters, theoretical predictions and hypothesis in details, section 3.2 provides a general description of the experimental procedure.

3.1 Experimental parameters and theoretical predictions

At the beginning of each period, we form groups of four players, one seller and three buyers. Each buyer i (with i = 1, …, 3) is assigned a private reservation value v_i independently drawn

[15] The result extends to Dutch auctions and first-price auctions.
[16] See, for example, McAfee and McMillan (1987).

from a uniform distribution with support {0, 1, 2, …, 59, 60}. The participants know exclusively their own reservation values, but not the values of the other subjects. The private valuation of the seller equals 20. We let know to the buyers that this value was also drawn from a uniform distribution with support {0, 1, 2, …, 59, 60}. Then in each group, the seller determines his reserve price, R, and the three buyers choose simultaneously a bidding price.

Buyers are informed whether the reserve price was reached or not. First, if there are one or more bidders with bids greater than the reserve price, the buyer with the highest bid win the item. If at least one bid is greater than the reserve price, the bidder who submitted the highest bid wins the auction and pays the maximum of the reserve price and the second highest bid submitted. In case of a tie in the high bid submitted, the high bidders are informed of which of them wins randomly the auction. The selected bidder pays his bid. Second, if no bidder submitted a bid greater than the reserve price, no sell occur and the seller keeps the item.

When the item is sold by auction, the bidder who wins the auction receives the difference between his valuation and the amount paid; the other bidders earn 0. The seller gets the amount paid by the winning bidder minus his own valuation. If the item is not sold by auction, bidders get 0 and the seller receive his own valuation.

The experiment is based on a factorial 2×2 design: There are four treatments which exclusively differ with respect to the information condition on the reserve price value and the possibility for buyers to overbid.

Reserve price Information	Overbidding	
	Allowed	Not allowed
Private	Treatment 1	Treatment 2
Public	Treatment 3	Treatment 4

Table 1: Presentation of the treatments

The main question of our study is whether private or public information about reserve price affects bidding behaviours, reserve price values and the efficiency of the auction mechanism. Therefore, in some of the treatments, participants take part to a secret reserve price auction in which they submit their bibs without knowing the value of the sellers' reserve price. In other treatments, subjects interact in a public reserve price auction in which they are informed about the value of the sellers' reserve price before submitting their bids. However, experimental studies on auctions point out overbidding behaviours (Kagel, 1989). In order to evaluate the impact of this behavioural regularity, we introduce treatments allowing or not buyers to overbid.

When overbidding is not allowed, buyers can't submit a bid higher than their own valuations of the item.

At the end of each period, the subjects were informed whether or not a sell occurs, for the buyers if they win the auction and the sell price, as well as their own payoff in the current period and their total profit up to this time.

To induce risk neutral preferences for sellers and buyers, we use a lottery procedure after each auction.[17] Subjects' earnings in the auction are measured in points. After the auction, each subject who won a positive number of points, h, face a lottery with two prizes, A=100 UME and B=0 UME. The probability of winning A is h/N, and the probability of winning nothing is 1-(h/N), where N is the maximum number of points that a subject can obtain in the auction. In the setting, the maximum number of points that any seller or buyer can obtain in the auction each period is N=40. On the one hand, if the object is sold by auction, the buyer who wins the auction can obtain a maximum number of 40 points when she has the maximum valuation of 60, the others have minimum valuations of 0, and the reserve price is the lowest feasible, $v_0 = 20$. Then, the buyer pays p=20 and obtains v-p=60-20=40 points. On the other hand, the seller can also obtain a maximum number of 40 points when at least two buyers' valuations are 60 and the reserve price is $R \leq 60$. Then, the winner buyer pays p=60 and the seller receives p-v_0=60-20=40 points. So the probability of winning the high prize, A=100 UME, for a subject who has earned h points is h/40. Note that inducing risk neutrality for buyers is innocuous theoretically, because bidders have a dominant strategy, which is to bid true valuation.

In table 2, we use the theoretical background developed in section 2 to compute the predictions tested in our experiment.

	Seller	Buyers
Equilibrium bidding	$R^* = 40$	$v_i = b_i$
Efficiency	$R^e = 20$	$v_i = b_i$

Table 2: theoretical predictions

Assuming participants are risk neutral, we derive the following hypotheses from our theoretical background.

Hypothesis 1: Bidders bid their true valuations. Thus, one should observe no difference in bidding between treatments.

[17] See, for example, Roth and Malouf (1979), Berg et al. (1986) and Berg et al. (2003)

⇒ If bidders have valuations greater than the publicly known reserve price, they bid their true valuation;

⇒ When bidders do not know the reserve price, all of them bid their true valuation.

Hypothesis 2: Reserve prices are optimal. Whether the reserve price is public or secret does not have any effect on reserve prices selected by sellers. Hence, for each sub-treatment, the earnings to the seller are the same on average in all treatments.

Hypothesis 3: The introduction of private or public reserve prices lowers the efficiency of auction mechanism.

Auctions are efficient mechanisms. In case of a reserve price, conflict may appear between the winner of the auction and the seller. Thus, all sells will not be implemented because of too low price offer.

3.2 Experimental procedure

In all experimental conditions described below, subjects participated as a seller or a buyer in a second price sealed bid auction, one seller and three buyers forming a group. Role assignment remained the same throughout the entire session. The experiments were run in the GATE experimental laboratory with 160 participants and consisted in 10 sessions, with each session comprising 40 periods. The participants were randomly recruited from a subject pool of students of several universities and the graduate school of management (Lyon). All of them were inexperienced in auction experiments and no subject participated in more than one of the sessions. In each of the 40 periods, one seller and three buyers were re-matched such that the same group did never interact in two consecutive periods. Therefore, in our setup, all the theoretical results hold for all periods: Since interaction is anonymous and one-shot the 40 periods are repetitions of static games and not a dynamic game giving rise to further equilibria.[18]

[18] All together, we collected 6400 observations, which provide us 3, respectively 2, independent observations for treatments 1 and 3 and for treatments 2 and 4.

Upon arrival, participants were randomly assigned to a specific computer terminal.[19] In the beginning of each session, instructions were distributed and read aloud (see Appendices 6.2 for an English translation). Clarifying questions were asked and answered privately. Then, we asked the participants to fill in a control questionnaire in order to check for understanding. Only after all questions had been correctly answered, the experiment started. The experiment was computerized using the REGATE software (Zeiliger 2000).

On average, each session lasted one hour, excluding payment of subjects. All amounts were given in ECU (*Experimental Currency Units*), with conversion into Euros at a rate of 1€ for 100 ECU for buyers and 150 ECU for sellers upon completion of the session. The final payment was the sum of the single payoffs of the 40 periods plus a 2€ show-up fee. The average payoffs per round (in ECU) and the standard deviations (in brackets) are reported in the following table:

Treatments		Sellers		Buyers	
Reserve price	Overbidding	Mean	Std. Dev.	Mean	Std Dev.
Private	Allowed	16.70	12.33	1.68	8.65
	Not allowed	12.68	10.00	3.04	6.47
Public	Allowed	19.70	10.97	1.23	8.98
	Not allowed	14.32	10.19	3.16	6.53

Table 3: Average earnings per round.

For each treatment the seller earns significantly more points than the buyers.

4. Experimental Results

Main differences arise from a comparison of bidding behaviours in public vs. secret reserve price treatment. Furthermore, the objective is then to compare behavioural differences related to information on the reserve prices (public vs. secret) and/or restriction on submitted bids. The econometric analysis evaluates the impact of treatment variables on individual proposals.

4.1. Reserve prices

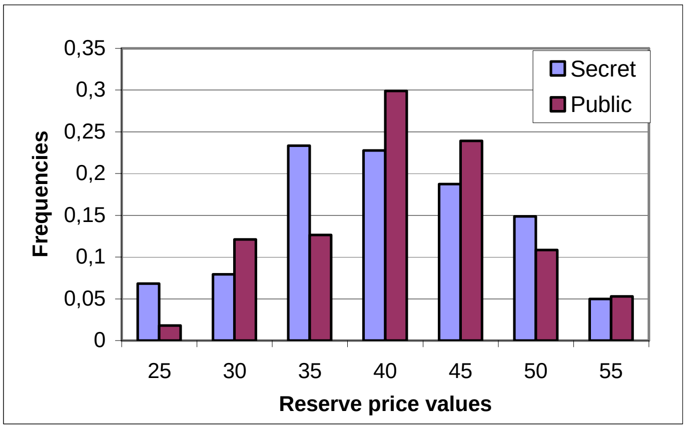
According to theoretical prediction, we obtain no differences in means by comparing public and secret reserve price distributions (see table 4 and figure 1.) Indeed, means and median values are close to the predicted reserve price.

[19] The GATE experimental laboratory has privacy conditions sufficient to assure that participants could not observe each other's decisions.

	With overbidding		Without over bidding		Total	
	Secret	Public	Secret	Public	Secret	Public
Mean	41,1	41,7	37,3	37.7	39,56	40,12
Median	42	41	35	39	40	40
Std. Dev.	8,31	7,33	6,36	7,17	7,81	7,52

Table 4 : Reserve prices

The distribution of reserve prices seems to be more flat in secret price treatments, which is consistent with other studies (Lucking Riley 2000.)



We run a random effect linear regression on reserve prices to investigate the effect of our strategic variables. In order to investigate the effect of our strategic and treatment variables on the individual behaviours, we run the following random effects linear regression (for each party):

$$y_{nt} = X_{nt}\,\beta + \varepsilon_{nt} \quad n = 1,\dots,N \text{ and } t = 1,\dots,T$$

$$\varepsilon_{nt} = u_n + v_t + w_{nt}$$

where X_{nt} is the vector of the independent variables and β the vector of the estimated coefficients. The number of individuals equals 120 (N=120) and number of periods equals 40 (T=40).

In our experiment, the variables, which characterize the model, are the explanatory variables 1 and 2 are the two treatment variables: These dummies study separately the impact of the information on the reserve price (variable public) and overbidding opportunity (variable overbid) on the buyers' bids. The cross variable (variable public*overbid) analyzes the joint influence of these two variables on bidding behaviour. By considering the variable begin (resp. end), we attempt to test the presence of a start (resp. end) game effect.

The results from model 1 relate to incentives. In model (2), we added characteristics of the participants as controlled variables. We have gender and we constructed dummies for graduate students and students in economics or in related fields (business, math, computer science), which are expected to perform better in experiment involving some aspects of game theory. The variable ¨Previous participant¨ informs us whether the subject has participated in a laboratory experiment in the past.

.

Dependant var.	Model 1		Model 2	
Reserve prices	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Cste	37.497	(1.637)	21.156^{***}	(7.181)
Public	0.556	(1.728)	1.791	(1.602)
Overbid	3.898^{**}	(1.764)	3.723^{**}	(1.591)
Pub*Overbid	0.0008	(0.005)	0.0007	(0.004)
Begin	-1.127^{**}	(0.495)	$- 1.127^{**}$	(0.545)
End	0.0320	(0.495)	0.031	(0.545)
Male			1.587	(1.740)
Student			8.789^{*}	(5.104)
Graduate			0.434	(1.211)
Eco. or related field student			1.895^{***}	(0.563)
Previous part.			1.567	(1.662)
R^2	24.5 %		6.2%	
Log-likelihood	-5530		-5305	
Nb. of obs.	1600		1600	
Table [20]				

According to theoretical prediction, the reserve prices are independent on the information conditions and significantly increase over time.

Result 1 : Sellers set similar reserve price under secret or public information conditions.

The absence of restriction on bidding behaviour increases significantly the reserve prices regardless the information condition on public reserve price.

[20] *** Statistically significant at 1%, **statistically significant at 5%, *statistically significant at 10%. Standards errors are reported in parenthesis.

4.2. Impact of a reserve prices on bidding behaviours

Following the experimental results, if no restriction applied on bids, the buyers' bids deviate strongly from equilibrium and efficiency. Indeed, their strategies consist of offering higher bids than their reservation values, such that both proportions are high, 48% or 86%, depending on the reserve price information. These results are illustrated in figure 3:

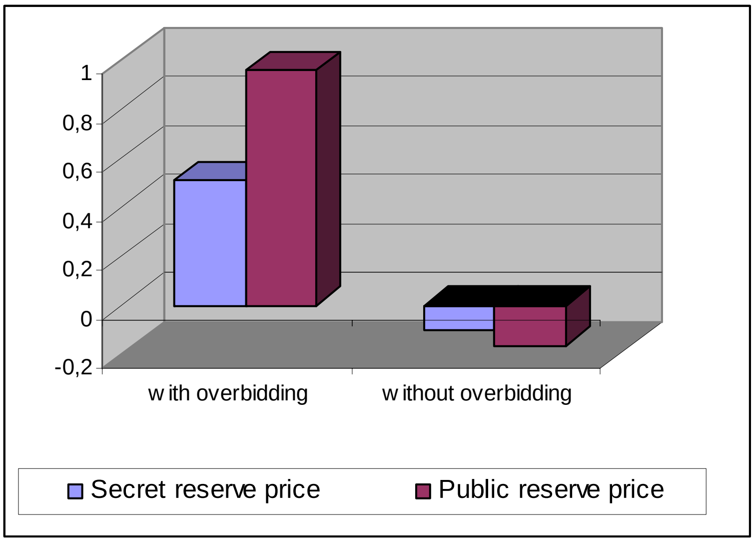


Figure 3

On the individual level, figures 1 and 2 report the bids made by participants depending on their private valuations. All points located on the straight-line correspond to the equilibrium and efficient bids (i.e. the player bids his reservation value $b_i = v_i$).

Bidding behaviours of buyers in secret reserve price treatments

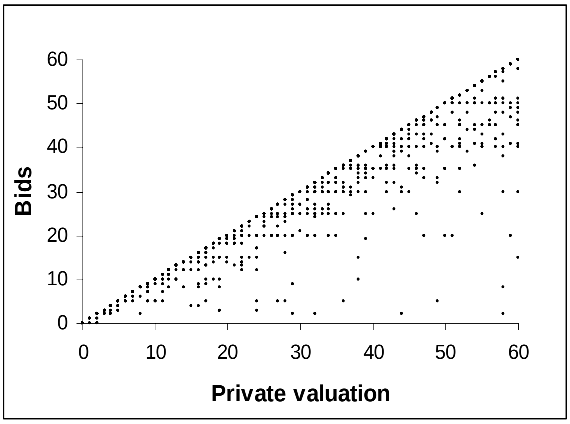


Figure 1A. Overbidding not allowed

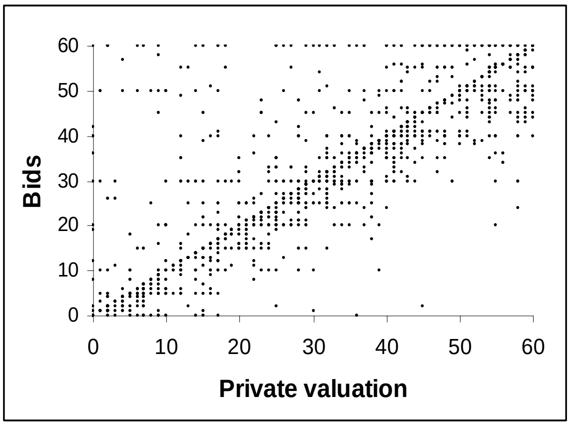


Figure 1B. Overbidding allowed

Bidding behaviours of buyers in public reserve price treatments

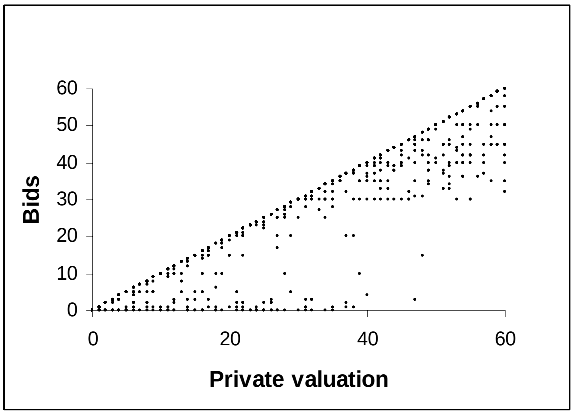


Figure 2A. Overbidding not allowed

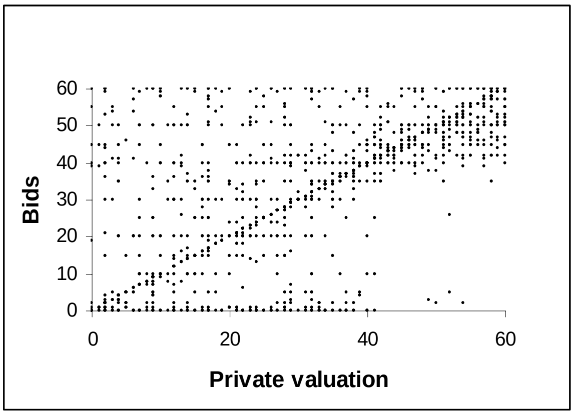


Figure 2B. Overbidding allowed

Result 2. When no restriction applies on bids, the buyers' behaviours deviate from equilibrium and efficiency by overbidding.

In public reserve price treatments, the deviations are more important. When the buyers submit a bid, they know the reserve price value demanded by the seller. Therefore, buyers, whose private valuation is lower than the reserve price set by the seller, have no opportunity of profit. The theory predicts that they should also bid their private valuation of the item. In fact, real buyers are discouraged and set either very low bids or overbids.

Result 3. Public reserve price discouraged buyers with private valuation lower than the minimum price demanded by the seller.

In order to investigate the effect of our strategic and treatment variables on the individual behaviours, we run the following random effects linear regression (for each party):

$$y_{nt} = X_{nt}\,\beta + \varepsilon_{nt} \quad n=1,...,N \text{ and } t=1,...,T$$

$$\varepsilon_{nt} = u_n + v_t + w_{nt}$$

where X_{nt} is the vector of the independent variables and β the vector of the estimated coefficients. The number of individuals equals 120 (N = 120) and number of periods equals 40 (T = 40).

In our experiment, the variables, which characterize the model, are the explanatory variables public and overbid. The cross variable (public*overbid) analyzes the joint influence of these two variables on bidding behaviour. Variable reserve price capture the influence of the reserve price value in public reserve price treatments. Variable value correspond to the private valuation of buyer *i*. Variable serious bidder is a dummy which indicate if the private valuation of buyer I is higher than the public reserve price. By considering the variable begin (resp. end), we attempt to test the presence of a start (resp. end) game effect.

The results from model 1 relate to incentives. In model (2), we added characteristics of the participants as controlled variables. We have gender and we constructed dummies for graduate students and students in economics or in related fields (business, math, computer science), which are expected to perform better in experiment involving some aspects of game theory. The variable ¨Previous participant¨ informs us whether the subject has participated in a laboratory experiment in the past.

Dependant var.	Model 1		Model 2	
Bids	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Cste	2.059**	(0.925)	0.296	3.077
Val.	0.828***	(0.008)	0.829***	0.008
Public	-12.530***	(1.651)	-13.115***	1.680
Public*reserve price	0.238***	(0.027)	0.236***	0.027
Overbid	4.153***	(1.129)	3.766***	1.192
Pub*Overbid	-2.209	(1.588)	-1.708	1.636
Serious bidder	37.882***	(0.953)	-0.622***	0.020
Serious bidder*val.	-0.622***	(0.021)	37.880***	0.946
Begin	-0.682**	(0.329)	-0.683*	0.3678
End	0.142	(0.329)	0.139	0.368
Male			-0.689	0.809
Student			1.233	2.326
Graduate			0.386	0.515
Eco. or related field student			0.008	0.005
Previous part.			0.198	0.869
R^2	75.98 %		76.32 %	
Log-likelihood	-20781		-17320	
Nb. of obs.	4800		4800	

Table [21]

When the seller knows that three bidders will take part to the auction, he uses the reserve price as a signal to enforce competition and overbidding behaviours.

[21] *** Statistically significant at 1%, **statistically significant at 5%, *statistically significant at 10%. Standards errors are reported in parenthesis.

Bids increase significantly with the private valuation of the item and the overbidding opportunity. Contrary to theoretical prediction, bids are significantly lower when the reserve price value is known.

Result 4. In public reserve price treatments, the bids depend significantly on the reserve price.

On the one hand, bids significantly increase with the reserve price value. On the other hand, buyers with private valuation higher or equal to the reserve price set by the seller set significantly higher bids but they are decreasing in their private valuation. The latter result is obvious because serious bidder have high private valuation of the object. Thus, they set higher bids than others. The former results points out that serious bidders do not overbid. Serious bidders are more likely to win the auction, which means that overbidding may be costly for them.

4.2. Probability of a sell

In order to investigate the effect of our strategic and treatment variables on conflict resolution, we run the following random effects Probit model:

$$y_{nt} = X_{nt}\,\beta + \varepsilon_{nt} \quad n=1,...,N \text{ and } t=1,...,T$$
$$\varepsilon_{nt} = u_n + v_t + w_{nt}$$
$$y_{nt} = 1 \text{ if } y_{nt} \geq 0$$
$$y_{nt} = 0 \text{ if } y_{nt} < 0$$

where X_{nt} is the vector of the independent variables and β the vector of the estimated coefficients. Furthermore, y_{nt} equals 1 if an agreement is reached and 0 otherwise.

We consider the variables public, overbid and public overbid to capture the effect of our strategic variable on the probability of a sell, as well as the private valuation of the three buyers and the reserve prices set by the seller. Variables begin and end capture respectively the possibility of a start and/or end game effects.

	Coefficient	Std. Dev.	Marginal effects	Std. Dev.
Cste	2.316***	0.492	0.309***	0.736
Public	0.742***	0.292	0.099**	0.052
Overbid	0.427	0.272	0.057	0.042
Pub*Overbid	-0.097	0.356	-0.0130	0.049
Reserve price	-9.047***	0.643	-1.209***	0.323
Bid 1	3.292***	0.236	0.4400***	0.127
Bid 2	2.827***	0.226	0.3779***	0.119
Bid 3	3.024***	0.255	0.404***	0.130
Begin	-0.152	0.119	-0.020	0.015
End	0.209**	0.138	0.028	0.019
ρ	0.086**	0.049		
Log-likelihood	-431.17			
Restricted Log-likelihood	-436.37			
Chi-squared	10.38			
% of predicted observations	87.35%			
Nb. of obs.	1600			

Table [22]

Despite the strong overbidding behaviours of the buyers, the absence of restriction on bids doesn't increase significantly the occurrence of a sell. Indeed, overbidding is more severe for no serious bidders. The probability of a sell increases with the private value of the three buyers. And, as noted in previous studies (Kathar, Lucking Rieley, 2000 and Reiley 2000 for fields experiments and Bajari, Hortaçsu, 2000, for econometric study), it decreases significantly with the value of the reserve price.

Result 5. The probability of a sell is a decreasing function of the reserve price value.

Public information on the reserve price influence bidders' behaviour and increase significantly the probability of a sell. This result is also reported in Katar and Lucking-Reiley (2000).

Result 6. Public reserve price increases the probability of a sell.

[22] *** Statistically significant at 1%, **statistically significant at 5%, *statistically significant at 10%. Standards errors are reported in parenthesis.

6. Appendix

6.1. Expected results for a common distribution.

Consider a common distribution, $F(v)$, with $F(\underline{v}) = 0$, $F(\bar{v}) = 1$, and $F(v)$ strictly increasing and differentiable over the interval $\lfloor \underline{v}; \bar{v} \rfloor$.

Auction with no reserve price:

In the second-price sealed-bid auction, bidders announce their true valuations, *v*, and win with probability $F^{n-1}(v)$. The expected payment to the buyer with value *v* is:

$$P(v) = \int_{\underline{v}}^{v} w dF^{n-1}(w) = vF^{n-1}(v) - \int_{\underline{v}}^{v} F^{n-1}(w) dw$$

His expected payoff is:

$$\pi^{e}(v) = vF^{n-1}(v) - P(v) .$$

His expected payment, contingent on winning, will be:

$$H(v) = \frac{P(v)}{F^{n-1}(v)} = v - \frac{\int_{\underline{v}}^{v} F^{n-1}(w) dw}{F^{n-1}(v)}$$

$$\underline{v} + \left(\frac{n+1-k}{n+1} \right) (\bar{v} - \underline{v})$$

For the general expressions of $P(v)$ and $H(v)$ see Bulow and Roberts (1989).

In a second-price (or ascending) auction, the seller's expected revenue Λ, is (see Riley and Samuelson (1981) for the general expression of Λ):

$$\Lambda = n \int_{\underline{v}}^{\bar{v}} [vF'(v) + F(v) - 1] F^{\,n+1}(v) dv$$

Reserve prices

If the seller announces a reserve price *R*, the expected revenue to the seller increases until Ω

$$\Omega = n \int_{R}^{\bar{v}} [vF'(v) + F(v) - 1] F(v)^{n-1} dv$$

The reserve price, which maximizes the expected revenue of the seller, is (Riley and Samuelson (1981):

$$R^{*} = v_{0} + \frac{1 - F(R^{*})}{F'(R^{*})}$$

6.2. Instructions (private vs public reserve price)

You take part in an experiment about decision making in economics in which you will have to make decisions. During that experiment, you will make money. Your earnings will depend on you decisions and the decisions of other persons.
Each of you will make individually her decision in front of her computer. Please do not try to communicate with other participants.
In the experiment, one seller and four buyers form an anonymous group. You will play 40 independent rounds of game. At the beginning of each round, the groups are rematch randomly with one seller and four buyers. You will either be a seller or a buyer and remained in that position of play during the all experiment.
Each group of participant has to agree on the exchange price of a good.

One round of play :

- Private valuation of the good -

At the beginning of each round, the buyers and the seller get a private valuation for the good.

⇒ For the buyers: their valuations correspond to the higher price that they agree to pay to buy the good. The private valuation are randomly and independently drawn in the interval: [0,1,..,59, 60]. Each integer in this interval has the same chance to be selected.

⇒ For the seller: her valuation corresponds to the lower price that they agree to accept to sell the good. The private valuation are randomly and independently drawn in the interval: [0,1,..,59, 60]. Each integer in this interval has the same chance to be selected.

- Reserve price -

Once informed about her private valuation, the seller makes a price offer. This price corresponds to his reserve price, i.e. the lowest bid he will accept.

(- Information of the buyers on the reserve price value -

Before to make a decision, the three buyers are informed on the reserve price selected by the seller.)

- Bid submission -

Once informed on her private valuation (and the reserve price and then) each of the four buyers submits simultaneously a bid.

- The selection of the buyer-

Cas 1 : If all the bids are lower than the reserve price of the seller, the sell is cancelled.

Cas 2 : If at least one of the four bids is higher than the reserve price of the seller, the sell occurs and the good is attributed to the buyer with the highest bid.

- Determination of the sell price -

If a sell occurs, the computer determines the sell price pay by the buyer to the seller. This price depends on the reserve price of the seller and the second highest bid of the four buyers.

- If the second highest bid is higher than the reserve price, the sell price is equal to the second highest bid.

- If the second highest bid is lower than the reserve price, the sell price is equal to the reserve price of the seller.

- Computation of the earnings –

In points :

If the sell occurs, the buyers and the seller received a number of points equals to :

- For the selected buyer, her private valuation minus the sell price.
- For the three other buyers, no point.
- For the seller, the sell price minus her private valuation.

If the sell is cancelled, the number of points of each participants (the seller and the three buyers) is equal and corresponds to zero.

In ECU: **How the computer determine the actual earnings of the seller and the selected buyer ?**

The computer randomly drawn a number in the interval [0,1, ..,39,40], each number has the same chance to be selected. Then, it compares this number with the number of point of the each participant.
If this number is lower than the number of points collected in the round, the participant (buyer or seller) earned the 100 ECU. Otherwise, his earning is null.

Feedback information at the end of each round:

At the end of each round, according to your decisions, you will be informed about the following elements:

- Your private valuation
- Your bid (for the buyer) ;
- Your reserve price (for the seller / **for all**)
- If the sell occurs ;
- If you are the selected buyer (i.e. the buyer who submitted the highest bid; for the buyer only)
- The sell price (if the sell occurs) ;
- Your earning for the round,

The earning computation for the experiment:

Your total earning for the all session is determined by the sum of your earnings in each round. The value of your account will be converted in euros with an exchange rate of 1 € for 150 ECU for the sellers and 3€ for 100 ECU for the buyers.

Before to start the experiment, we will ask to fill an understanding questionnaire about these instructions. To go further, all participants have to answer correctly to all the questions.

At the end of the experiment, we will ask you to give us information about your age, sex, level and field of study, university or school and either or not you had already take part in an experiment.

Please, take some additional time to read again these instructions. If you have any question, please, raise hand up; we will come to answer your questions.

During the all session, we kindly ask you to not ask question or speak loudly.
Thanks for you cooperation.

References.

Bajari, P. and Hortaçsu, A., 2000, Winner's Curse, Reserve Prices and Endogenous Entry: Empirical Insights from eBay Auctions, *Stanford University Working Paper*, 1-49.

Bulow, J. and Roberts, J., 1989, "The Simple Economics of Optimal Auctions. *Journal of Political Economy* 97 (5): 1060-90.

Burguet, R. and Sákovics, J., 1996. "Reserve Prices without Commitment. *Games and Economic Behavior* 15: 149-64.

Kagel, J.H., 1995, Auctions: A Survey of Experimental Research, in the *Handbook of Experimental Economics*, J. Kagel and Roth A., eds Princeton: Princeton University Press, 501-585.

Klemperer, P., 1999, Auction Theory: A Guide to the Literature. *Journal of Economic Surveys* 13 (3): 227-86.

Katkar, R., and Lucking-Reiley, D., 2000, Public versus Secret Reserve Prices in eBay Auctions: Results of a Pokémon Field Experiment, *Working Paper*, Vanderbilt University.

Levin, D. and Smith, J., 1996, Optimal Reservation Prices in Auctions, *Economic Journal*, 106: 1271-1282

Lucking-Reiley, D., 2000, Field Experiments on the Effects of Reserve Prices in Auctions: More Magic on the Internet, *Working Paper*, Vanderbilt University.

Lucking-Reiley, D., 2000, Auctions on the Internet: What's Being Auctioned, and How? *Journal of Industrial Economics* 48: 227-252.

McAfee, R.P. and McMillan, J., 1987, Auctions and Bidding. *Journal of Economic Literature* 25: 699-738.

McAfee, R.P. and Vincent, D.R., 1997, Sequentially Optimal Auctions. *Games and Economic Behavior* 18: 246-76.

Riley, J.G. and Samuelson W.F. 1981, Optimal Auctions. *American Economic Review* 71 (3): 381-92.

Samuelson W. F., 1985, Competitive Bidding with Entry Costs. *Economics Letters*, 17: 53-57.

Vickrey, W., 1961, Counterspeculation, Auctions, and Competitive Sealed Tenders. *Journal of Finance* 16 (1): 8-37.

Vincent, D.R., 1995, Bidding Off the Wall: Why Reserve Prices May be Kept Secret. *Journal of Economic Theory* 65: 575-84.