Economics Letters 119 (2013) 55–59

Contents lists available at SciVerse ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Using clock auctions to dissolve partnership: An experimental study

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ARTICLE INFO

Article history:
Received 29 September 2012
Received in revised form
15 December 2012
Accepted 27 December 2012
Available online 29 January 2013

JEL classification:
C7
C9
D8

Keywords:
Partnership dissolution
Clock auction
Risk aversion

ABSTRACT

We experimentally study clock auctions to dissolve partnerships jointly owned by two players. Subjects are found to deviate systematically from the Nash equilibrium. We explain the bidding behaviour in terms of risk aversion and/or non-standard utility theory.

1. Introduction

We propose clock auctions to dissolve partnerships between two players. Specifically, we study descending (ascending) clock auctions in which players stop the clock to buy from (sell to) the other. Experiments are conducted to analyse players' behaviour, and the results are compared with those of Yu et al. (2010).

2. Theoretical prediction

2.1. Settings and assumptions

Two risk-neutral players $i \in I = \{1, 2\}$ use a clock auction to dissolve a jointly owned partnership. Player i owns θ_i ($\theta_i \geq 0,\ i = 1, 2$) of the partnership initially, and $\theta_1+\theta_2 = 1$. Each player draws his private valuation v_i for the entire partnership from a commonly known distribution $F(v)$ with the support $[v_l, v_u]$. $F(v)$ has a positive and continuous density function $f(v)$. Finally, we assume that the partnership is perfectly complementary, so players are indifferent between having an incomplete share and having nothing.

2.2. Clock auction mechanism

In an ascending auction, the price clock starts from v_l and ascends continuously until one of the two players stops the clock. Suppose that player 1 stops the clock when the unit price reaches p, then under the auction rule, player 1 sells his share θ_1 of the partnership to player 2 for a total price of $\theta_1 \cdot p$. Hence, the payoffs to the two players, π_1 and π_2, are

$$\pi_1 = \theta_1 \cdot p,$$
$$\pi_2 = v_2 - \theta_1 \cdot p.$$

In a descending auction, the price clock descends from v_u. The player who stops the clock must buy his opponent's share. Suppose that player 1 stops the clock at unit price p, then he must purchase θ_2 of the partnership from player 2 for a total cost of $\theta_2 \cdot p$ and the payoffs are

$$\pi_1 = v_1 - \theta_2 \cdot p,$$
$$\pi_2 = \theta_2 \cdot p.$$

An extension of Milgrom and Weber (1982)'s isomorphism result is the strategic equivalence between the clock auction we propose and the two extreme cases of $k+1$ price sealed bid auction ($k = 0, 1$) in Cramton et al. (1987).

Proposition 1. *The Nash equilibrium in a descending (ascending) auction is the same as the Bayesian Nash equilibrium in the first (second) price auction.*

According to Yu et al. (2010), the following propositions present the Nash equilibrium in clock auctions when the private valuation is uniformly distributed.

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0165-1765/$ – see front matter
doi:10.1016/j.econlet.2012.12.034

Table 1
Treatments.

	Symmetric	Asymmetric
Ascending	Ascending sym.	Ascending asym.
Descending	Descending sym.	Descending asym.

Proposition 2. *If $v \sim U[v_l, v_u]$, p^* is a Nash equilibrium in a descending clock auction, where*

$$p^*(v,\theta) = \begin{cases} (v - v_l)/(2-\theta) & \text{if } \theta \le 1/2, \\ \min\{(v - v_l)/(2-\theta), (v_u - v_l)/(1+\theta)\} \\ \quad \text{if } \theta > 1/2. \end{cases}$$

Proposition 3. *If $v \sim U[v_l, v_u]$, p^* is a Nash equilibrium in an ascending clock auction, where*

$$p^*(v,\theta) = \begin{cases} \max\{(v + \theta v_u)/(1+\theta), v_u(1-\theta)/(2-\theta)\} \\ \quad \text{if } \theta < 1/2, \\ (v + \theta v_u)/(1+\theta) & \text{if } \theta \ge 1/2. \end{cases}$$

3. Experimental design

Our clock auction experiments used a 2×2 design (Table 1). Under the asymmetric treatment, player 1 and player 2 are endowed with either a 1/4 or a 3/4 share of a partnership with 50% probability in each round. Under the symmetric treatment, both players are endowed with a 1/2 share of a partnership in each round.

A total of 16 sessions (4 sessions for each treatment) were conducted in the Smith Experimental Economics Lab at Shanghai Jiao Tong University. 24 subjects participated in each session for five rounds, preceded by two trial rounds. Players were randomly matched in each round. One of the five rounds was randomly selected to calculate the final payment. There was a RMB5 show-up fee. Each session lasted about one hour, and the average payoff was RMB39 (the exchange rate was about USD1 = RMB6.3).

All players drew their private valuations independently from a discrete uniform distribution of [0,10], in increments of 0.1. There was a 10-s countdown before the auction clock started ticking. The price clock descended from 10 or ascended from 0 at the rate of 0.1/3 s. Once the clock was stopped, the auction ended and the partnership was dissolved.

Players were instructed that they could only stop the clock to sell their own shares in the ascending auction, and to buy their opponents' shares in the descending auction.

The buyer's payoff equalled his valuation for the partnership minus the price he paid and the seller's payoff equalled the amount that the buyer paid.

4. Results and discussion

4.1. Efficiency

Efficiency in this study is defined as the valuation of the winner divided by the higher valuation of the two players. The dissolution is expected to be efficient in symmetric treatments. However, in asymmetric treatments, the Nash equilibrium is no longer efficient. In Table 2 we present the average efficiency both as predicted by the Nash equilibrium based on realised valuations and initial shares, and as observed in the experiment.

The comparison between the predicted and actual average efficiencies shows that a partnership is more efficiently dissolved in a descending auction than in an ascending auction. Note that the predicted average efficiency in the ascending symmetric treatment is higher than in the descending asymmetric treatment, but the ranking is reversed for the actual average efficiency. In Table 3, we

Table 2
Predicted and actual efficiency.

Treatment	Predicted average efficiency	Actual average efficiency
Ascending asym.	0.953	0.852
Ascending sym.	1.000	0.864
Descending asym.	0.979	0.906
Descending sym.	1.000	0.936

Table 3
p-value for comparing efficiencies using the Wilcoxon rank sum test.

	Ascending sym.	Descending asym.	Descending sym.
Ascending asym.	0.490	0.026	0.000
Ascending sym.	/	0.136	0.000
Descending asym.	/	/	0.025

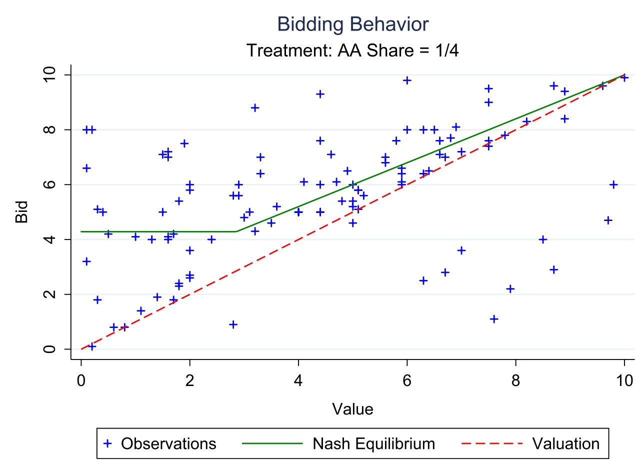

Fig. 1. Bidding behaviour in #1.

confirm that the auction format has a large effect. One explanation is that in a descending auction a bidder with a lower valuation is less likely to stop the clock first because doing so will incur a loss, whereas this is not the case for a bidder with a higher valuation in an ascending auction.

4.2. Bidding behaviour

Figs. 1–6 illustrate the price at which the clock was stopped. The solid lines and the dashed lines represent the Nash equilibrium and the private valuations, respectively. Players' bids deviate from the equilibrium in most cases. In the ascending auctions, the majority of bids are lower than the Nash equilibrium: 57.7% when $\theta = 1/4$, 80.6% when $\theta = 3/4$ and 62.9% when $\theta = 2/4$. In the descending auction, off-equilibrium behaviour is more evident as most bids are scattered above the Nash equilibrium.

Tables 4 and 5 summarise the deviation from the risk-neutral Nash equilibrium. The deviations are significant, except when the initial share is $\theta = 1/4$ in the ascending symmetric treatment (#1). Players significantly underbid in #2 and #3 and overbid in the descending auctions (#4, #5 and #6). Column 6 in Tables 4 and 5 lists the results of the corresponding $k+1$ price auctions from Yu et al. (2010). The individual behaviour in the first price auction is consistent with that in the descending auction, but the behaviour in the second price auction differs from that in the ascending auction. Players overbid in first-price auctions in a statistically weaker sense than in descending auctions—the significance of the deviation in the former is 10% when $\theta = 2/4$ or 3/4 and 1% when $\theta = 1/4$, compared with 0.1% in all three categories of descending auction. In ascending auctions, the difference in the second price