

Response to Referee #3

Thank you again for your diligence, your comments, and your suggestions. They were all helpful to me as I prepared the revisions. In what follows, I put excerpts from your report in bold. Here is how the paper was revised in response to your suggestions:

1. **However, I am a bit concerned about the applications and importance of the results in the current paper. Does equilibrium behaviour with discrete strategy space provide any insights that are missing in the literature on all-pay auctions with continuous strategy space? Are there any empirical/experimental evidences suggest the equilibrium behaviour in discrete bidding strategy space setting fits better to the data? If the continuous strategy space is good enough in describing actual behaviour in reality, then the results in the current paper is not very important. Indeed, some of the equilibrium behaviour, e.g., the high valuation player only bid on odd numbers whereas the low valuation player only bid on even numbers, are not intuitive and I find it difficult to imagine people behaving in such a way.**

I address this point you raised below:

- (a) I added the following sentences into the second paragraph of section 1 (Introduction)

“However, strategy space is always discrete in reality. Specially, in experiments of all-pay auction, different with predictions under continuous strategy space, over-bidding is common [Fehr and Schmid, 2010, Gneezy and Smorodinsky, 2006], and subjects’ bids are not uniform [Ernst and Thöni, 2013, Liu, 2014]. Besides, there are huge heterogeneity among subjects in experiments [Davis and Reilly, 1998, Deck and Sheremeta, 2012, Klose and Kovenock, 2013, Mago and Sheremeta, 2012]. Dechenaux et al. [2006] point out that these findings are related to possible multiple equilibria, especially asymmetric equilibria, in all pay auction with discrete strategy space. Therefore, studies for all-pay auction with discrete strategy space is valuable to understand experimental data and subjects’ strategic behaviors in real life.”

- (b) With discrete strategy space, though player x ’s strategy choices do not affect her expected payoff V_x , she could choose equilibrium strategy to affect player y ’s expected payoff V_y . “the low valuation player only bid on even numbers” implies she used a strategy that maximize the opponent’s expected payoff. This behavior must be connect with her kindness or higher order belief.

References:

- Dietmar Fehr and Julia Schmid. Exclusion in the all-pay auction: An experimental investigation. *Available at SSRN 1815001*, 2010
- Uri Gneezy and Rann Smorodinsky. All-pay auctions — an experimental study. *Journal of Economic Behavior & Organization*, 61(2):255–275, 2006
- Christiane Ernst and Christian Thöni. Bimodal bidding in experimental all-pay auctions. *Games*, 4(4):608–623, 2013
- Tracy Xiao Liu. All-pay auctions with endogenous entry timing: An experimental study. *Working Paper*, 2014
- Douglas D Davis and Robert J Reilly. Do too many cooks always spoil the stew? an experimental analysis of rent-seeking and the role of a strategic buyer. *Public Choice*, 95(1-2):89–115, 1998
- Cary Deck and Roman M Sheremeta. Fight or flight? defending against sequential attacks in the game of siege. *Journal of Conflict Resolution*, 56(6):1069–1088, 2012
- Bettina Klose and Dan Kovenock. The all-pay auction with complete information and identity-dependent externalities. *Economic Theory*, pages 1–19, 2013
- Shakun D Mago and Roman M Sheremeta. Multi-battle contests: An experimental study. *Available at SSRN 2027172*, 2012
- Emmanuel Dechenaux, Dan Kovenock, and Volodymyr Lugovskyy. Caps on bidding in all-pay auctions: Comments on the experiments of a. rapoport and w. amaldoss. *Journal of Economic Behavior & Organization*, 61(2):276–283, 2006

2. **When bidding strategy is discrete, equilibrium behaviour is sensitive to tie-breaking rules. For example, Dechenaux et al. 2006 characterized equilibria of all-pay auction with discrete strategy space and homogeneous players when none of the players receives any payments in ties. The authors also show that the equilibrium behaviour depends on whether the cap is an odd or even number. To connect to the small literature on discrete strategy space and be clear about the contribution of the current paper, I suggest the author discuss the effect of tie-breaking rules and caps on equilibrium bidding behaviour.**

Thank you very much for your suggestion. I added the following sentences after Proposition 5

“Under favor-one-sided tie-breaking rule, the form of equilibria is independent to the parity of the value of object, whether there is a cap and homogeneous or not. Since only two probabilities of bidding strategy is undetermined, we could test whether players’ behavior in the experiment is consistent with predications of Nash Equilibrium.”

3. Finally, in the introduction (page 1 paragraph 2 line 7), the current paper may not be the first to examine asymmetric equilibria for symmetric players when bidding space is discrete. Dechenaux et al. 2006 shows asymmetric equilibria may exist for symmetric players when bidding space is discrete. If this is the case, please cite the paper and make the relevant correction.

Thank you for the suggestion. I have changed the wording accordingly.

Thank you again for your helpful and careful comments. I hope I have satisfactorily addressed all your concerns.

References

- Douglas D Davis and Robert J Reilly. Do too many cooks always spoil the stew? an experimental analysis of rent-seeking and the role of a strategic buyer. *Public Choice*, 95 (1-2):89–115, 1998.
- Emmanuel Dechenaux, Dan Kovenock, and Volodymyr Lugovskyy. Caps on bidding in all-pay auctions: Comments on the experiments of a. rapoport and w. amaldoss. *Journal of Economic Behavior & Organization*, 61(2):276–283, 2006.
- Cary Deck and Roman M Sheremeta. Fight or flight? defending against sequential attacks in the game of siege. *Journal of Conflict Resolution*, 56(6):1069–1088, 2012.
- Christiane Ernst and Christian Thöni. Bimodal bidding in experimental all-pay auctions. *Games*, 4(4):608–623, 2013.
- Dietmar Fehr and Julia Schmid. Exclusion in the all-pay auction: An experimental investigation. *Available at SSRN 1815001*, 2010.
- Uri Gneezy and Rann Smorodinsky. All-pay auctions — an experimental study. *Journal of Economic Behavior & Organization*, 61(2):255–275, 2006.
- Bettina Klose and Dan Kovenock. The all-pay auction with complete information and identity-dependent externalities. *Economic Theory*, pages 1–19, 2013.
- Tracy Xiao Liu. All-pay auctions with endogenous entry timing: An experimental study. *Working Paper*, 2014.
- Shakun D Mago and Roman M Sheremeta. Multi-battle contests: An experimental study. *Available at SSRN 2027172*, 2012.