Multi-Battle Contests: An Experimental Study

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Motivation

- Many real life situations such as patent races, R&D competition, spots tournaments, and elections can be modeled as contests of multiple battles

- In such contests, players **expend resources** and effort in order to win **individual battles** and the player who wins certain number of battles receives the **final prize**

- Such multi-battle contests have attracted the attention of many prominent scholars (Borel, 1921; Tukey, 1949; Blackett, 1954; Bellman, 1969; Snyder, 1989; Harris and Vickers, 1985, 1987)

Theory

- Szentes and Rosenthal (2003) and Konrad and Kovenock (2009), S&R and K&K henceforth.

- Both models capture the environment of a multi-battle contest, with the difference that S&R captures the **simultaneous**, while K&K captures the **sequential** multi-battle contest.

- Both models assume that the player expending the **highest bid wins** the individual battle with certainty

- The winner of the overall multi-battle contest is the player who wins **the majority of battles**.

Prediction

- The qualitative prediction of S&R model is that players should make **positive bids in all battles**, with all bids restricted by certain theoretical boundaries.

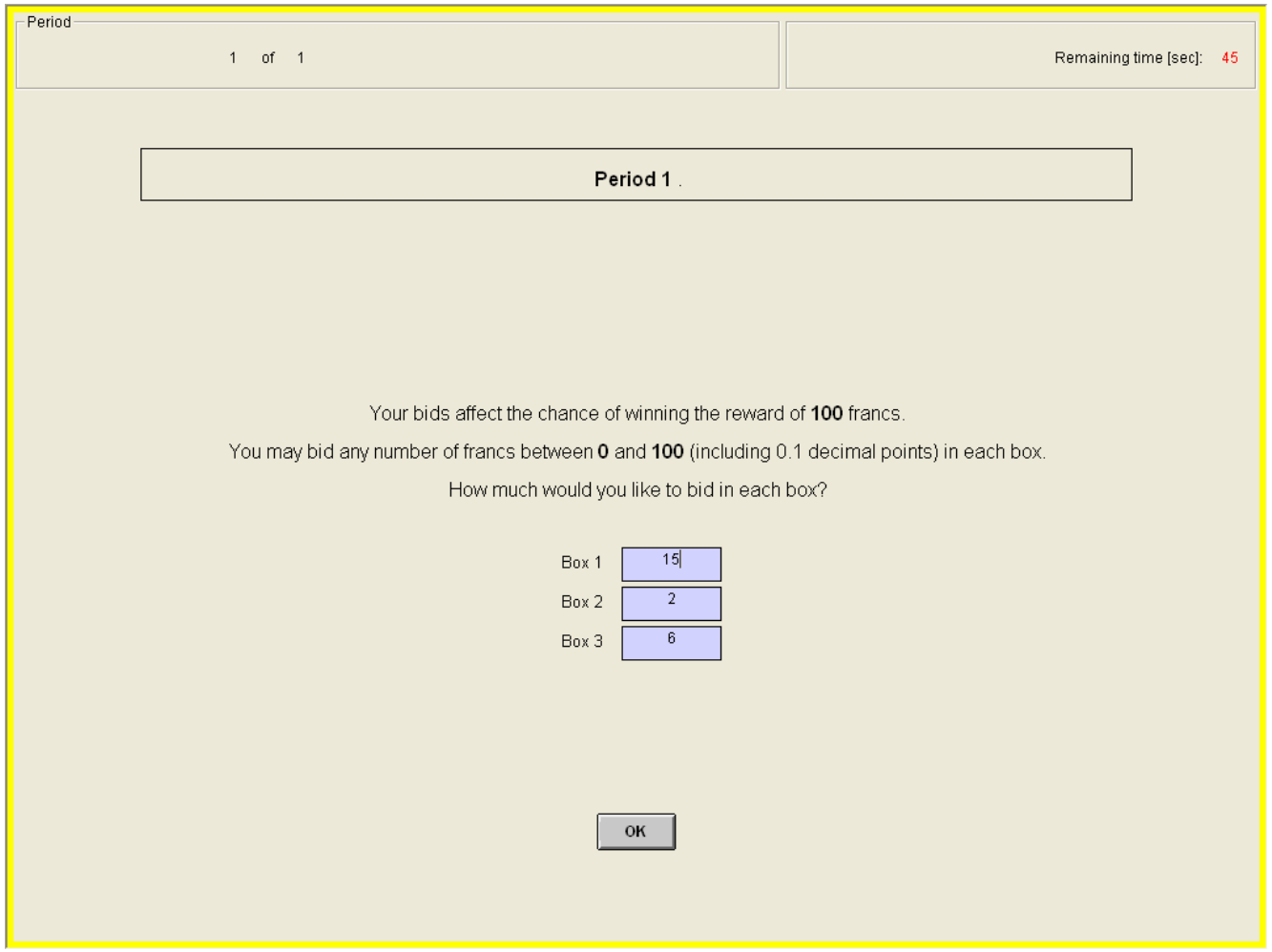
- The qualitative prediction of K&K model is that players should make **positive bids only in the first battle**, without making any bids in the subsequent battles.

- Because of the cut-throat nature of the all-pay auctions, the expected level of expenditures in both models is equal to the value of the prize.

Experiment

- n=3 battles
- v=100 experimental francs
- Two treatments: Sequential and Simultaneous
- z-Tree (Fischbacher, 2007)
- Six sessions with 12 subjects per session
- Random matching
- Participation fee of $20

Decision Screen



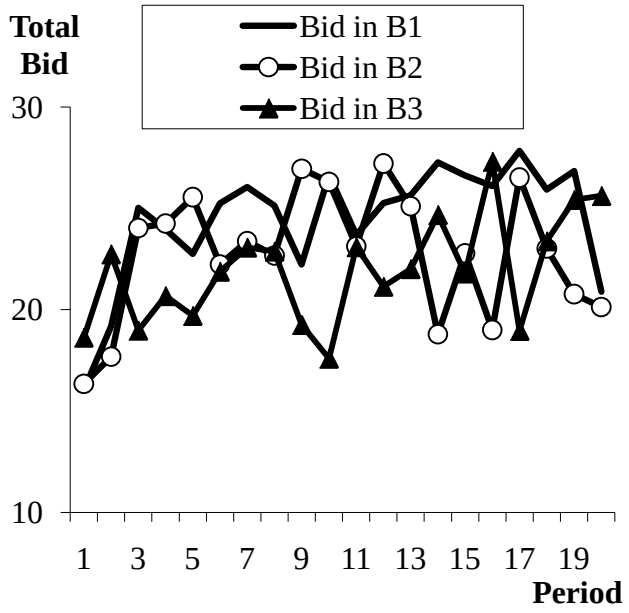
Predictions and Results

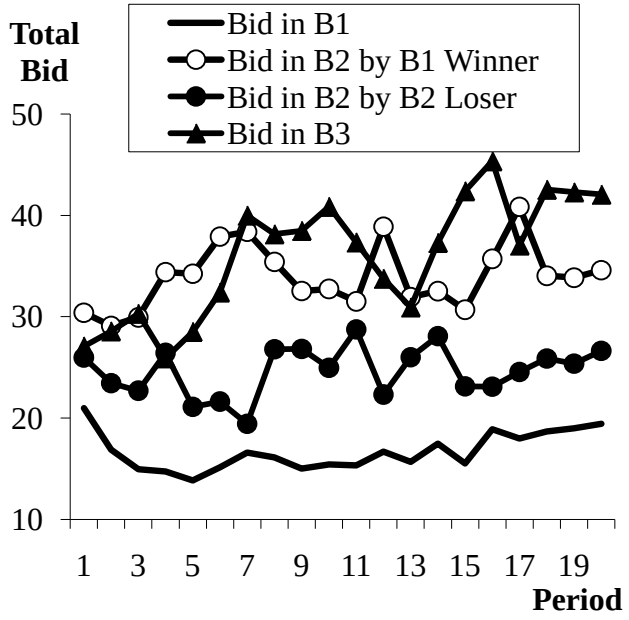
Treatments	Sequential		Simultaneous	
Prize, *v*	100		100	
Number of battles, *n*	3		3	
	Equilibrium	Actual	Equilibrium	Actual
Expected bid in B1	50.0	16.7 (0.5)	16.7	24.4 (0.6)
Expected bid in B2 by B1 winner	0.1	34.0 (1.0)	16.7	22.8 (0.6)
Expected bid in B2 by B1 loser	0.0	24.7 (1.0)	-	-
Expected bid in B3	50.0	35.7 (1.0)	16.7	21.9 (0.6)
The probability of ending in B2	1.0	0.62 (0.02)	-	-
Expected average total bid	50.0	59.6 (1.3)	50.0	69.2 (0.9)
Expected payoff	0.0	-9.6 (1.8)	0.0	-19.15 (1.7)

We do not find a difference between expected bid in B3 by winners and losers of B2. Therefore, we combine the data for the bids in B3.

Results

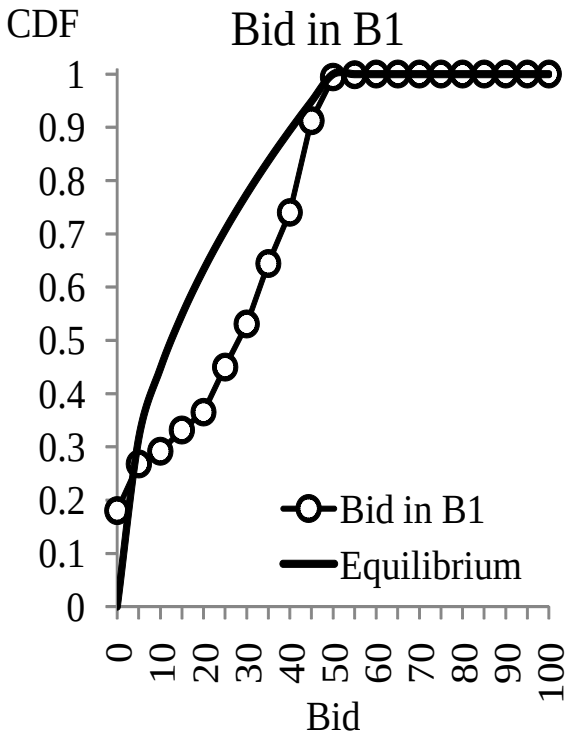
- **Finding 1**: Average total bid in the simultaneous and sequential contests is significantly higher than predicted.

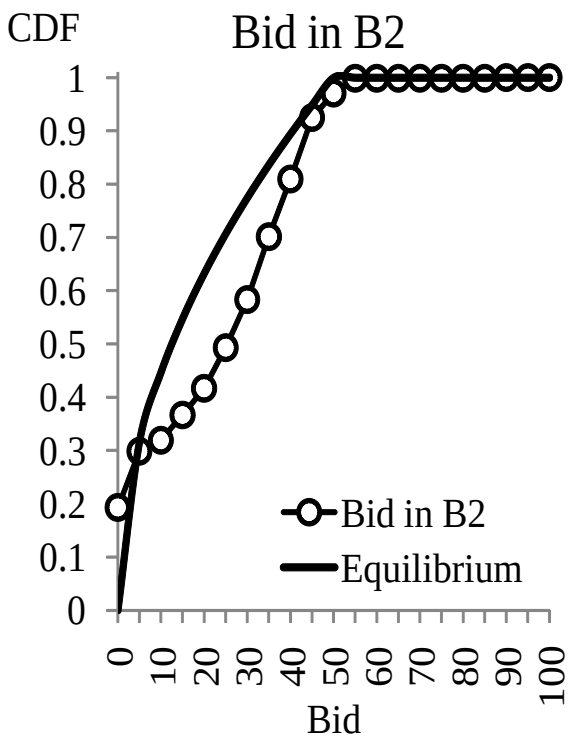


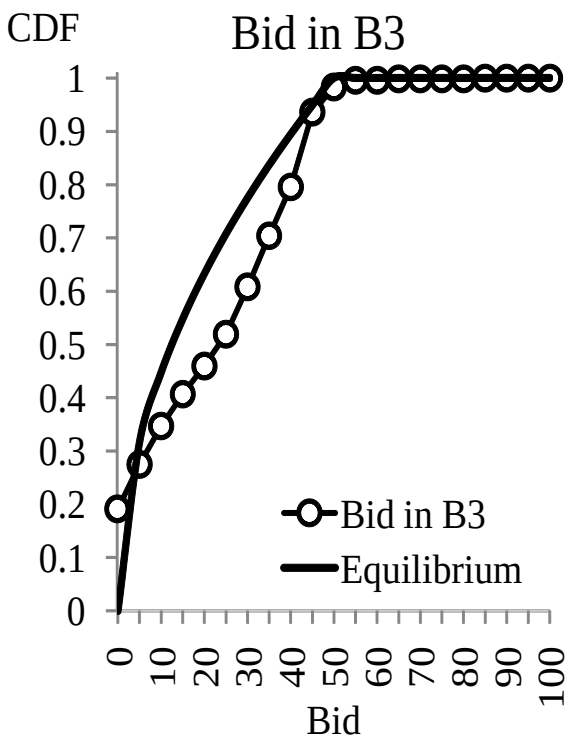


Simultaneous Contest

- **Finding 2**: In the simultaneous contest, subjects make positive bids in each battle 80% of the time and bids fall within theoretically predicted boundaries.

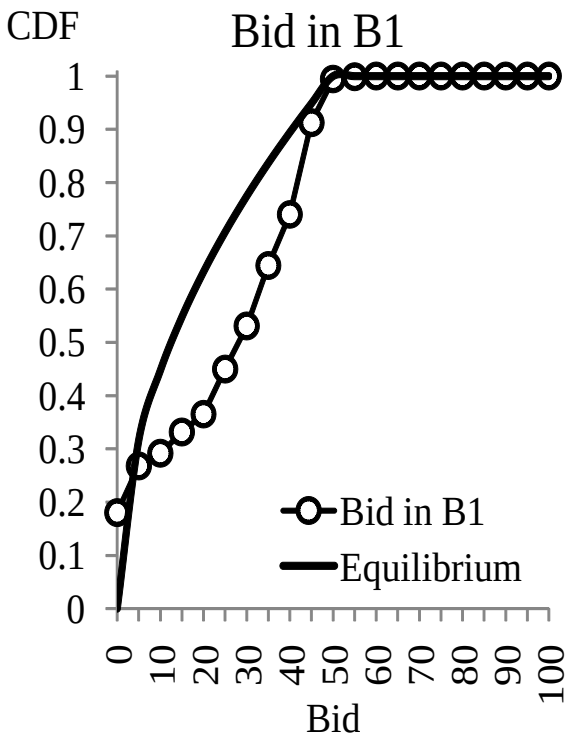


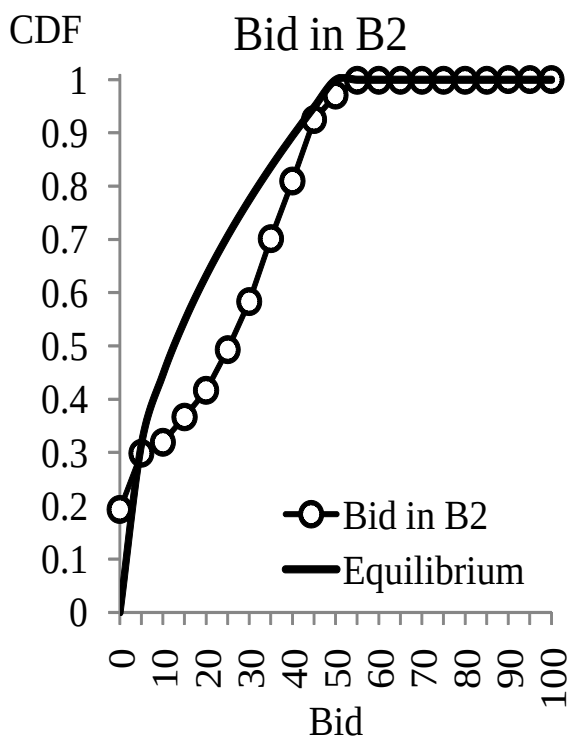


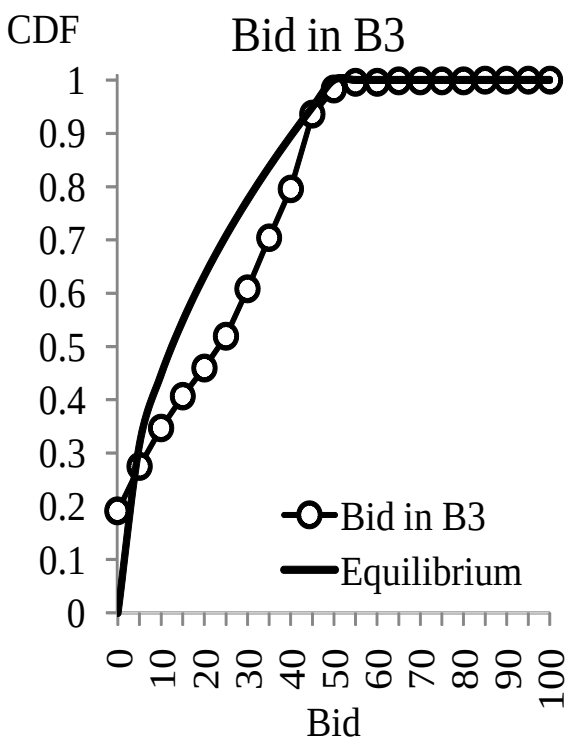


Simultaneous Contest

- **Finding 3**: 35% of the time subjects make positive bids in only two out of three battles (instead of all three) and they significantly overuse moderately high bids.





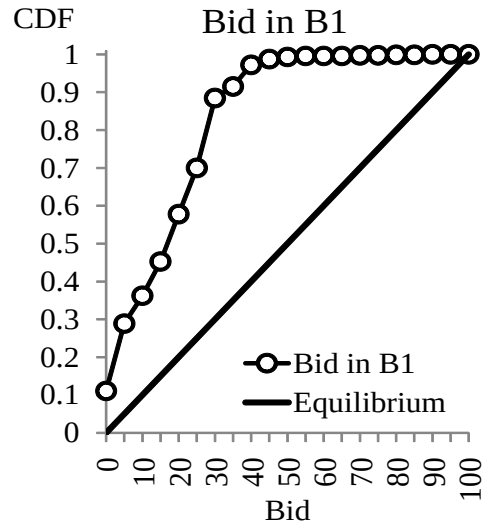


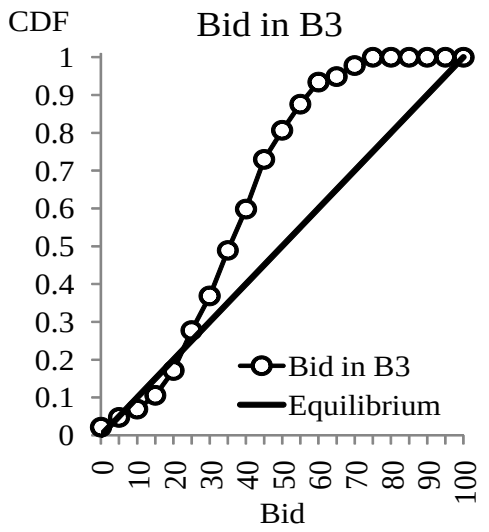
Simultaneous Contest

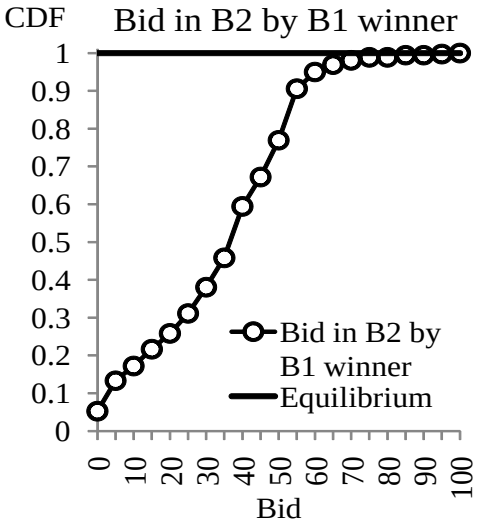
- **Explanations**:
- To win the overall contest, a player needs to win only two out of three battles. This entails that players can randomly select and focus their expenditure on just two battles.
- Kovenock et al. (2010) also report behavior consistent with 'guerilla warfare' strategy in the weakest-link contest. Together these results suggest that such behavior may be a robust phenomena observed in the multi-battle contests.

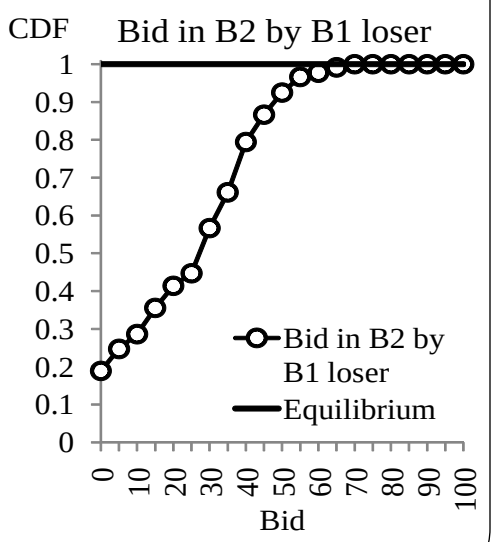
Sequential Contest

- **Finding 4**: In the sequential contest, subjects significantly underbid in the first battle and make significantly higher bids in the subsequent battles.



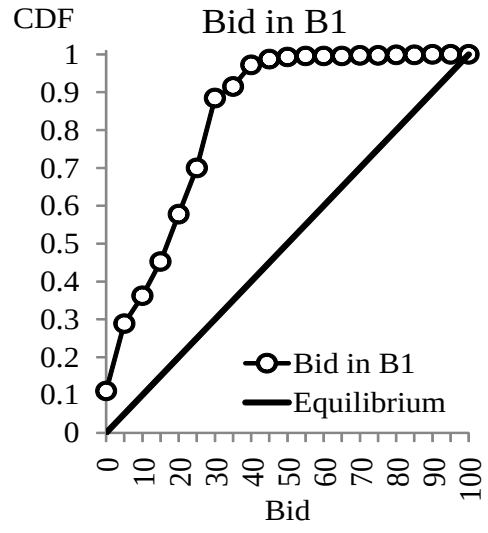


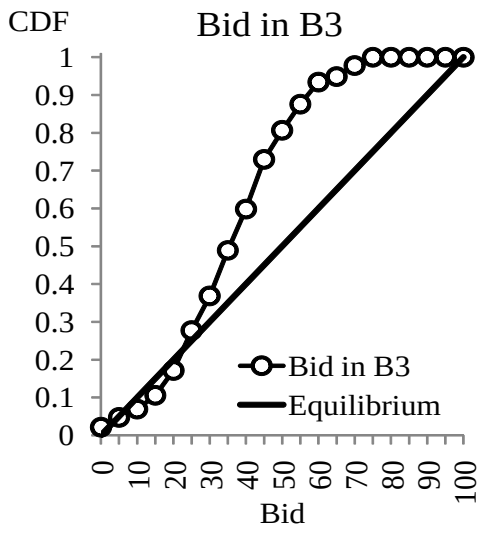


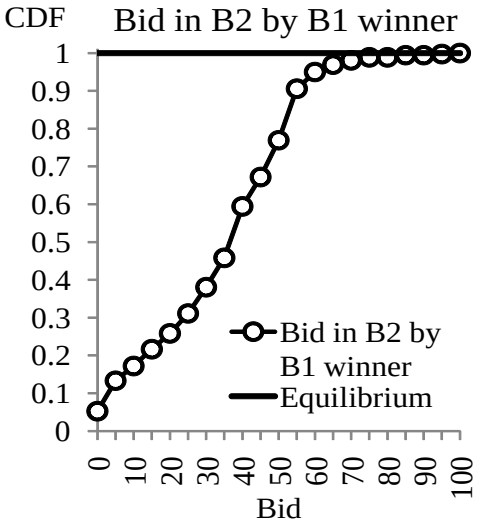


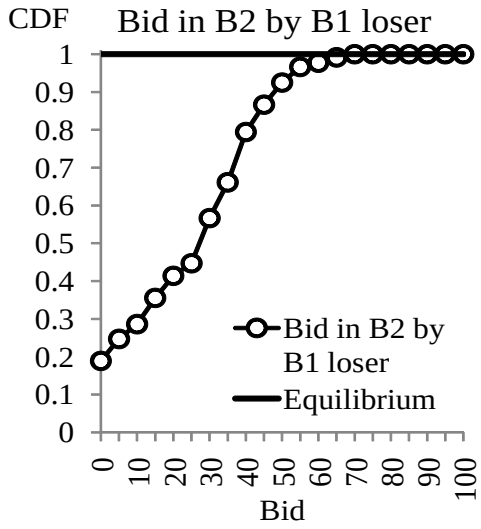
Sequential Contest

- **Finding 5**: In the sequential contest, instead of ending the contest in the second battle, contest proceeds to the third battle 38% of the time.









Sequential Contest

- **Explanations**:
- Sub-optimal behavior (SPNE). The average bid of 35.7 in the third battle implies that subject's expected payoff from the third battle is positive (0.5*100-35.7=14.3).
- A non-monetary utility of winning (Sheremeta, 2010). Such a contest, inherently transforms into a multi-battle sequential contest with intermediate prizes (Konrad and Kovenock, 2009).

Conclusion

- Consistent with S&R model, subjects make positive bids in each battle 80% of the time and bids fall within theoretically predicted boundaries.

- Contrary to predictions of S&R model, 35% of the time subjects make positive bids in only two out of three battles (instead of all three) and they significantly overuse moderately high bids.

Conclusion

- Contrary to predictions of K&K model, subjects significantly underbid in the first battle and make significantly higher bids in the subsequent battles. As the result, instead of always ending in the second battle, contest proceeds to the third battle 38% of the time.

- Finally, in both S&R and K&K, subjects make higher bids than the equilibrium.