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Overbidding and Heterogeneous Behavior in Contest Experiments: A Comment on the Endowment Effect

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We revisit the meta-analysis of Sheremeta (2013) on overbidding in contest experiments and focus on the effect of endowment on overbidding. Whereas Sheremeta (2013) assumes that there is a monotonic relationship between endowment and overbidding in his meta-analysis, Baik et al. (2014) find an inverted-U shaped relationship in the analysis of a single experiment. We use the same data as in Sheremeta (2013), but employ a different econometric model which leads to support for the inverted-U shaped relationship. Following Baik et al. (2014) we explain the result in terms of a wealth effect.

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We revisit the meta-analysis of Sheremeta (2013) on overbidding in contest experiments and focus on the effect of endowment on overbidding. Whereas Sheremeta (2013) assumes that there is a monotonic relationship between endowment and overbidding in his meta-analysis, Baik et al. (2014) find an inverted-U shaped relationship in the analysis of a single experiment. We use the same data as in Sheremeta (2013), but employ a different econometric model which leads to support for the inverted-U shaped relationship. Following Baik et al. (2014) we explain the result in terms of a wealth effect.

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We thank Roman Sheremeta for sharing the meta-data and for useful comments. Any remaining errors are our own.

1. Introduction

The experimental literature on rent-seeking contests (*à la* Tullock, 1980) has exposed the broadly robust phenomenon of overbidding – defined as the observed bids being higher than the bid predicted by Nash equilibrium. Researchers have suggested several explanations for this phenomenon. In this respect, Sheremeta (2013) provides a very important contribution with a meta-analysis bringing together results from 30 prominent experiments on rent-seeking contests. Along with various other explanations for overbidding such as bounded rationality, utility of winning, other-regarding preferences, probability distortion, and the shape of the payoff function, he shows that the size of endowment, i.e., the amount available to be spent on the contest, positively and significantly affects overbidding.

The conclusion above is reached through an OLS regression in which the dependent variable is the average overbidding rate in a particular experiment, and the independent variables are the relative (to the prize value) size of the endowment, the number of contestants, a dummy for the fixed matching protocol, and a dummy for one-shot contests.[1] In this regression, the results of which are presented in Equation (4) of Sheremeta (2013, p. 493), the coefficient on "endowment" turns out to be positive and significant at the 5% level. Sheremeta (2013) explains this finding in terms of confusion in subjects. As the level of endowment increases, there is simply more scope for errors resulting from confusion, and on average over-bidding will inevitably increase. This can be explained in the framework of popular error models such as the Quantal Response Equilibrium (QRE).

This is certainly an important result not only in the area of contest experiments, but also in the conflict literature since it constitutes (albeit indirect) evidence of the relationship between the resource availability and conflict intensity in a controlled setting. Baik et al. (2014) exclusively investigate this question and run an experiment that provides a direct test of the relationship. In between-subject treatments they provide the subjects with different endowments for the same prize value. They find that the effect of endowment on bidding (and overbidding) takes the form of an inverted-U shaped relationship. In other words, bidding initially increases with endowment and reaches a maximum, before decreasing if endowment is increased further. Error models such as QRE cannot explain this phenomenon. Baik et al. (2014) explain this in terms of a wealth effect: above a certain level, the endowment is viewed by the subject as wealth which tends to reduce bids. In fact, Baik et al. (2014) run an additional "wealth" treatment in which subjects are given a medium endowment and also a fixed wealth that cannot be used in the conflict. The result for this treatment resembles the one in which the subjects are given high level of endowment:

[1] Average overbidding rate is defined as: (submitted bid – Nash equilibrium bid)/ Nash equilibrium bid. In a correspondence with us Sheremeta mentioned that the endowment is defined as the ratio of the size of the bidding strategy space to the prize value. So, it did not distinguish between a treatment where a subject is given 100 and can bid up to 50 for a prize of 50, and a treatment where a subject is given 50 and can bid up to 50 for a prize of 50.

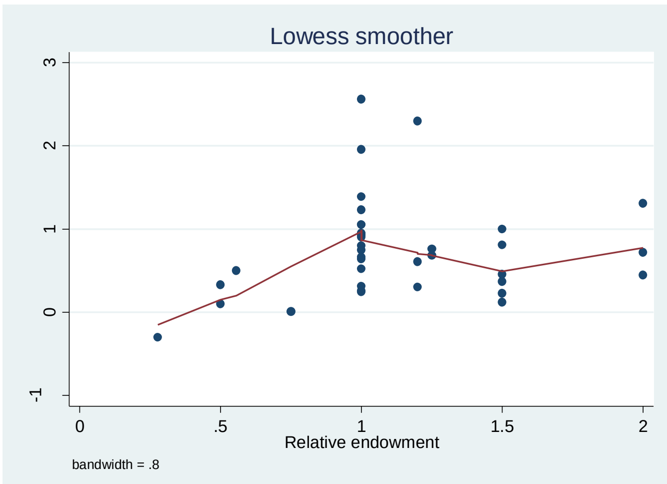
they bid low. This adds further weight to the conclusion that high endowments are being perceived by subjects as wealth.

Given the clear importance of the topic but inconclusive findings, we here seek to revisit the meta-analysis by Sheremeta (2013). Since Sheremeta (2013) focuses on various other important issues such as heterogeneous behavior, social preference etc., a linear regression model with a linear effect of endowment was deemed satisfactory for the research objectives. Here, using exactly the same meta-data,[2] we extend Sheremeta's (2013) econometric model in a way that allows the identification of a non-linear effect of endowment. Our results are reported in the next section.

2. Result

We first draw a scatter plot of the overbidding rate against the endowment size relative to the prize value, as in Sheremeta (2013). Figure 1 presents this scatter plot along with a Lowess smoother. This smoother reveals an overall increase in bid over the observed range of endowment. However, the exact shape of the relationship, particularly in the middle of the range, is far from clear, and it appears that there may well be an element of non-linearity here.

Figure 1. Lowess smoother



To test this formally, we run an OLS regression as in Sheremeta (2013) in which the dependent variable is the overbidding rate and the independent variables are the ones used by him, viz. relative endowment, number of players, matching protocol dummy, and a one-shot game dummy,[3] and in addition

[2] We are indebted to Roman Sheremeta for allowing us to use the meta-data in Sheremeta (2013).
[3] Note that Equation (4) of Sheremeta (2013) does not appear to include the one-shot game dummy. However, his end-note 5 indicates that such a dummy was included in estimation, but excluded from the results on the grounds of having an insignificant effect.

the square of relative endowment. The inclusion of this last variable is what enables us to test for a non-linear effect.

In fact, we run three different estimations, and the results are presented in Table 1. The first set of results exactly reproduces the results of Sheremeta's (2013) Equation (4). The second set of results is for the same regression, but with cluster standard errors: clustered at the level of published study. The sample consists of 39 results from 30 studies. Some studies provide more than one result, with a maximum of five. It is conceivable that there is dependence at the level of studies, and cluster standard errors make an appropriate adjustment for this. We see that the cluster standard errors differ slightly from the OLS standard errors. Importantly, the significance of the effect of relative endowment is down-graded to "mild" significance (0.05 < p < 0.10) as a result of the cluster standard error being slightly larger than the OLS standard error.

Table 1: Regression results.

Dep. Variable: overbidding rate	**Sheremeta**	**Sheremeta (with cluster se's)**	**Extended model (with cluster se's)**
Relative Endowment	0.431^{**}	0.431^{*}	2.373^{***}
	(0.206)	(0.228)	(0.792)
Relative Endowment squared			-0.815^{**}
			(0.315)
Number of players	0.204^{***}	0.204^{***}	0.199^{***}
	(0.041)	(0.032)	(0.031)
Partner matching	-0.078	-0.078	0.019
	(0.169)	(0.152)	(0.141)
One shot game	0.293	0.293	0.341^{*}
	(0.198)	(0.264)	(0.170)
Constant	-0.411	-0.411	-1.472
	(0.271)	(0.266)	(0.466)
N	39	39	39
R-squared	0.51	0.51	0.60
Adjusted R-squared	0.45	0.45	0.54

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Numbers in parentheses are OLS standard errors in Column 2, and cluster standard errors (clustered by study) in Columns 3 and 4.

The final set of estimates is from the model including the quadratic term, relative endowment squared. Note that this is a superior model as the adjusted R^2 has risen from 0.45 to 0.54 as a consequence of including the quadratic term. Also observe that the effects of both relative endowment and its square are significant, the former at 1% and the latter at 5% levels. The signs of these two coefficients, being respectively positive and negative, confirm the inverted-U shaped relationship postulated above, and tentatively inferred from inspection of Figure 1.

Of interest is the relative endowment at which effort is maximized. From the point of view of the contest organizer, whose objective is presumably to maximize bids, this level of endowment may be seen as "optimal". An estimate of this optimal endowment may be deduced from the coefficients of relative endowment and its square, and a standard error and confidence interval for this quantity can be obtained using the delta method (Oehlert, 1992).[4] The estimate of optimal relative endowment is found to be 1.46, with confidence interval (1.18, 1.73). The position of the confidence interval conveys evidence that the optimal relative endowment is somewhat greater than one.

An additional point of interest in the results of the extended model is that the one-shot game dummy now has a mildly significant positive effect. This result is in line with standard intuition since it is known that with repeated interaction bids usually go down (due to learning, tacit collusion etc.). The strongly positive effect of number of players persists through all estimations.

3. Conclusion

We have replicated the meta-analysis of Sheremeta (2013) with the same meta-data, while focusing on the effects of endowment on overbidding. We have implemented a different specification that includes a quadratic term for the relative endowment and clustering at the level of published study. The results show that overbidding has an inverted-U shaped relationship with endowment. This result is consistent with the result of Baik et al. (2014), and we have followed those authors by explaining it in terms of a wealth effect. When endowment is increased then it increases the strategy space as well as wealth. At first the increase in the strategy space allows scope for higher error (as described in Sheremeta, 2013) and induces higher overbidding. But after a certain point, as endowment continues to increase, the error effect stops and the wealth effect kicks in. As a result overbidding decreases.

Further, the dummy for one-shot game shows the same sign as in Sheremeta (2013) but becomes mildly significant. The remainder of the results obtained by Sheremeta (2013) still qualitatively hold. Our

[4] If the coefficients on relative endowment and its square are β_1 and β_2 respectively, the optimal relative endowment (i.e., the level at which effort is maximised) is given by $-\beta_1 /(2\,\beta_2)$. The delta method may be implemented using the nlcom command in STATA. For further details see Moffatt (2015).

results, as a side note, also demonstrate that clustering at the level of study can be important in meta-analyses in which some studies have given rise to multiple observations.

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