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

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Abstract

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, and finds evidence of, an increasing linear relationship between endowment and overbidding in his meta-analysis, Quantal Response Equilibrium (QRE) predicts an increasing concave relationship, and Baik et al. (2016) find an inverted-U shaped relationship in their 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 both QRE and the inverted-U shaped relationship. Following Baik et al. (2016) we posit that the inverted-U relationship may be interpreted in terms of a wealth effect.

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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 studies on rent-seeking contests, and applying 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.[1,2] In this regression, the coefficient on 'endowment' turns out to be positive and significant at the 5% level. 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 resource availability and conflict intensity in a controlled setting.

Since Sheremeta (2013) addresses a number of important issues such as heterogeneous behavior, social preference and so on, a linear regression model with a linear effect of endowment was deemed satisfactory for the research objectives. In this paper, we seek to address the important question of whether the effect of endowment is in fact non-linear, or even non-monotonic.

A non-linear effect of endowment on bids is predicted by more than one theory. One explanation is in terms of confusion in subjects, and this explanation is articulated within the framework of the Quantal Response Equilibrium (QRE).[3] As the endowment rises, the strategy space expands, leading to greater scope for errors, and hence a higher average bid. However, if the endowment rises above the amount of the prize, further increases in bids are not expected because bids higher than the amount of the prize lead to negative payoffs and are therefore heavily penalized by the quantal response equilibrium. Hence, QRE leads to the prediction that bids are an *increasing concave* function of endowment. This is, in fact, the pattern that was found (in an experiment with modest endowments) by Sheremeta (2011).

Baik et al. (2016) investigate the effect of endowment, and run an experiment that provides a direct test of the relationship. They increase the rent-seeking budget from Low to Medium to High and find that the effect of endowment on bidding (and overbidding) takes the form of an *inverted-U* shaped relationship.

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[1] Sheremeta (2013) defines the overbidding rate as (submitted bid – Nash equilibrium bid) / Nash equilibrium bid. He defines relative endowment as the ratio of the size of the bidding strategy space to the prize value. A consequence of the latter definition is that the meta-analysis does not distinguish between, for example, a design in which a subject is given 100 and can bid up to 50 for a prize of 50, and one in which a subject is given 50 and can bid up to 50 for a prize of 50.

[2] The results of this regression are presented in Equation (4) of Sheremeta (2013, p. 493). Note that 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 a statistically insignificant effect.

[3] Studies applied QRE to contest data include Sheremeta (2011), Chowdhury et al. (2014) and Lim et al. (2014).

They explain this pattern in terms of a wealth effect: above a certain level, the endowment is viewed by the subject as wealth which reduces the marginal utility of winning the rent, leading to a reduction in bids. In fact, Baik et al. (2016) 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: they bid low. This adds further weight to the conclusion that high endowments are being perceived by subjects as wealth.

Here we use exactly the same meta-data as Sheremeta (2013), and extend the econometric model to allow the identification of a non-linear effect of endowment. Our results are reported in the next section.

2. Results

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-monotonicity. Preliminary investigation of such non-montonicity is possible by performing a simple regression separately for observations with relative endowment less than or equal to one, and for those with relative endowment greater than or equal to one.[4] The first regression yields a statistically significantly positive slope estimate (t = +3.18; p = 0.004), while the second yields one that is negative but statistically insignificant (t = -1.11; p = 0.274). This difference provides preliminary evidence either of a structural break around 1, or of a non-monotonic relationship of the type discussed in Section 1.

Figure 1. Lowess smoother

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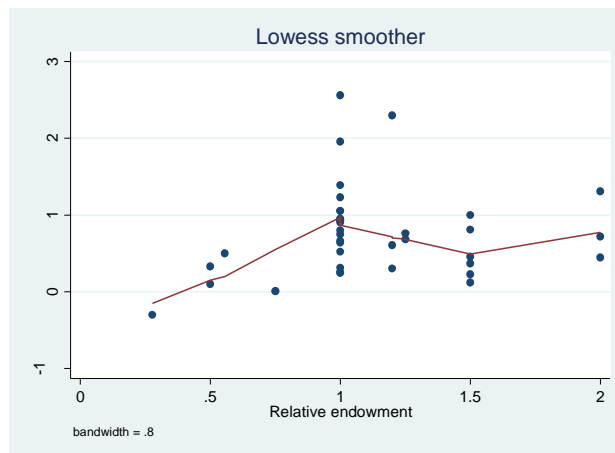
[4] Note that observations with relative endowment equal to 1 are used in both regressions to allow both regressions to have reasonable sample sizes. Clustered (at the level of study) standard errors are used in these regressions.

More formal analysis of the relationship is performed by extending the regression used by Sheremeta (2013) to include the square of relative endowment, in addition to relative endowment itself. It should be noted that, ideally, in line with best practice in meta-analysis, weighted least squares (WLS) should have been used for this purpose, with weights related to the standard error of the over-bidding rate. Unfortunately, however, in many of the studies on which the meta-analysis is based, it is not possible to extract the standard error, and in some it is even not possible to extract the sample size on which the mean over-bidding rate is based. Hence, WLS is not possible for these data, and we follow Sheremeta (2013) by using OLS. Another aspect of best practice in meta-analysis, which we do follow here, is the clustering of standard errors (see, e.g, Oczkowski and Doucouliagos, 2014). The sample consists of 39 results from 30 studies. Some studies provide more than one result, with a maximum of five. It is highly likely that there is dependence at the level of studies, and cluster standard errors make an appropriate adjustment for this. In fact, we run three different estimations, and the results are presented in Table 1.

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 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. 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.

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, provide support for the inverted-U shaped relationship postulated above, and tentatively inferred from inspection of Figure 1.

Of further 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).[5] 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

The principal contribution of this paper has been to extend Sheremeta's (2013) meta-analysis to include a quadratic term in the relative endowment. The key result is that this quadratic term has a statistically significant negative coefficient, and this is consistent with the hypothesis that the effect of endowment on overbidding in contests is inverted-U shaped. We have interpreted the downward sloping portion of the inverted-U shape in terms of a wealth effect (Baik et al., 2016). This result has important implications. For example, in the context of rent-seeking contests it indicates that for a given prize value, a very wealthy lobbying group is predicted to expend less lobbying effort than a moderately wealthy

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[5] 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).

counterpart. A qualification of this conclusion is that, since the implied maximum of the inverted-U is fairly far to the right within the range of relative endowment, the result must also be seen as consistent with the prediction of QRE, that bids are an increasing concave function of relative endowment.

What is clear from the results is that the relationship is non-linear. Which of QRE or the wealth effect (or indeed some other theory) is the best theory for explaining the exact form of the non-linear relationship is a worthwhile objective for further research.

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