Appendix

Title: Who are we up against? Heterogeneous group contests with incomplete information

Authors: Vasudha Chopra, Hieu Nguyen, and Christian A. Vossler

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This appendix includes:

- Extended theory model
- Proofs of propositions for the case of $r = 1/2$
- General theory solution for $0 < r < 1$, and simulation results
- Supplemental data analysis: Tables B.1 to B.11
- Representative experiment instructions
- Post-experiment questionnaire

Appendix A: Theory

Extended theory model

The data lend support to a model that includes in-group altruism and, possibly, a non-monetary utility of winning that is proportional to the prize value. For the complete information case, the optimization problem and associated first-order condition are:

[A.1] $\max U_{ig} = \left[1 + \alpha \cdot \left(n_g - 1\right)\right] \frac{X_g}{X_g + X_{-g}} v_g \cdot (1 + \gamma) - c_g x_{i,g} - \alpha \sum_{j \neq i} c_g x_{j,g}$

[A.2] $\left[1 + \alpha \cdot \left(n_g - 1\right)\right] v_g \cdot (1 + \gamma) \frac{X_{-g}}{\left(X_g + X_{-g}\right)^2} = c_g.$

The symmetric Nash equilibrium is:

[A.3] $X_g^* = \frac{\left[1+\alpha\left(n_{-g}-1\right)\right](1+\gamma)v_{-g}}{c_{-g}\left\{1+\frac{v_{-g}\left[1+\alpha(n_{-g}-1)\right]\ c_g}{v_g\ \left[1+\alpha(n_g-1)\right]\ c_{-g}}\right\}^2}$ and $X_{-g}^* = \frac{\left[1+\alpha\left(n_g-1\right)\right](1+\gamma)v_g}{c_g\left\{1+\frac{v_g\ \left[1+\alpha(n_g-1)\right]\ c_{-g}}{v_{-g}\left[1+\alpha(n_{-g}-1)\right]\ c_g}\right\}^2}$.

Importantly, the equilibrium effort is higher for the strong team when the source of advantage is group size. Regardless of the source of advantage, relative to the standard model, group effort increases by a factor of $\left[1 + \alpha\left(n_g - 1\right)\right](1 + \gamma)$. Table A.1 presents the equilibria for each source of advantage.

In the incomplete information setting, the optimization problem and associated first-order condition is:

[A.4] $\max_{x_{ig}} U_{ig} = \left[1 + \alpha(n_g - 1)\right] \left(r \frac{X_g}{X_g + X_S} + (1 - r) \frac{X_g}{X_g + X_W}\right) v_g \cdot (1 + \gamma) - c_g x_{i,g} -$

$\alpha \sum_{j \neq i} c_g x_{jg}$

[A.5] $\left[1 + \alpha \cdot \left(n_g - 1\right)\right] v_g \cdot (1 + \gamma) \left(r \frac{X_S}{\left(X_g + X_S\right)^2} + (1 - r) \frac{X_W}{\left(X_g + X_W\right)^2}\right) = c_g.$

Assuming $r = \frac{1}{2}$, the symmetric Bayesian-Nash equilibrium is:

$$[A.6] \quad X_S^{**} = \frac{[1+\alpha(n_S-1)](1+\gamma)v_S}{c_S}\left(\frac{4\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}+\left(1+\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}\right)^2}{8\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}\left(1+\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}\right)^2}\right);$$

$$X_W^{**} = \frac{[1+\alpha(n_W-1)](1+\gamma)v_W}{c_W}\left(\frac{4\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}+\left(1+\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}\right)^2}{8\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}\left(1+\frac{c_S\, v_W[1+\alpha(n_W-1)]}{c_W\, v_S\; [1+\alpha(n_S-1)]}\right)^2}\right).$$

As in the case of complete information, relative to the standard model, effort is scaled by a factor of $\left[1+\alpha\left(n_g-1\right)\right](1+\gamma)$. Table A.2 presents the equilibria for each source of advantage.

Table A.1 Equilibrium effort in *complete* information: expanded model

Source of heterogeneity	Contest type	Equilibrium effort
Cost-of-effort	Uneven	$(X_S^*, X_W^*) = \left(\frac{[1+\alpha(n-1)](1+\gamma)vc_W}{(c_S+c_W)^2}, \frac{[1+\alpha(n-1)](1+\gamma)vc_S}{(c_S+c_W)^2}\right)$
	Even	$(X_S^*, X_S^*) = \left(\frac{[1+\alpha(n-1)](1+\gamma)v}{4c_S}, \frac{[1+\alpha(n-1)](1+\gamma)v}{4c_S}\right)$; $(X_W^*, X_W^*) = \left(\frac{[1+\alpha(n-1)](1+\gamma)v}{4c_W}, \frac{[1+\alpha(n-1)](1+\gamma)v}{4c_W}\right)$
Prize Value	Uneven	$(X_S^*, X_W^*) = \left(\frac{[1+\alpha(n-1)](1+\gamma)v_D v_A^2}{c(v_A+v_D)^2}, \frac{[1+\alpha(n-1)](1+\gamma)v_A v_D^2}{c(v_A+v_D)^2}\right)$
	Even	$(X_S^*, X_S^*) = \left(\frac{[1+\alpha(n-1)](1+\gamma)v_S}{4c}, \frac{[1+\alpha(n-1)](1+\gamma)v_S}{4c}\right)$; $(X_W^*, X_W^*) = \left(\frac{[1+\alpha(n-1)](1+\gamma)v_W}{4c}, \frac{[1+\alpha(n-1)](1+\gamma)v_W}{4c}\right)$
Group Size	Uneven	$(X_S^*, X_W^*) = \left(\frac{[1+\alpha(n_S-1)]^2[1+\alpha(n_W-1)](1+\gamma)v}{c\,\{[1+\alpha(n_S-1)]+[1+\alpha(n_W-1)]\}^2}, \frac{[1+\alpha(n_W-1)]^2[1+\alpha(n_S-1)](1+\gamma)v}{c\,\{[1+\alpha(n_S-1)]+[1+\alpha(n_W-1)]\}^2}\right)$
	Even	$(X_S^*, X_S^*) = \left(\frac{[1+\alpha(n_S-1)](1+\gamma)v}{4c}, \frac{[1+\alpha(n_S-1)](1+\gamma)v}{4c}\right)$; $(X_W^*, X_W^*) = \left(\frac{[1+\alpha(n_W-1)](1+\gamma)v}{4c}, \frac{[1+\alpha(n_W-1)](1+\gamma)v}{4c}\right)$

Notes: An "uneven" contest refers to a case where a strong (S) team plays a weak (W) team. The strong team has either a lower cost of effort (i.e., $c_S < c_W$), higher prize value ($v_S > v_W$), or larger group size (i.e., $n_S > n_W$) relative to the weak team. In an "even" contest, both groups are of the same type (strong or weak).

Table A.2 Equilibrium effort *incomplete* information contests: expanded model

Source of heterogeneity	Equilibrium effort
Cost-of-effort	$X_S^{**} = \frac{[1+\alpha(n-1)](1+\gamma)v}{c_S}\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right)$ $X_W^{**} = \frac{[1+\alpha(n-1)](1+\gamma)v}{c_W}\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right)$
Prize Value	$X_S^{**} = \frac{[1+\alpha(n-1)](1+\gamma)v_S}{c}\left(\frac{4\frac{v_W}{v_S}+\left(1+\frac{v_W}{v_S}\right)^2}{8\left(1+\frac{v_W}{v_S}\right)^2}\right)$ $X_W^{**} = \frac{[1+\alpha(n-1)](1+\gamma)v_W}{c}\left(\frac{4\frac{v_W}{v_S}+\left(1+\frac{v_W}{v_S}\right)^2}{8\left(1+\frac{v_W}{v_S}\right)^2}\right)$
Group Size	$X_S^{**} = \frac{[1+\alpha(n_S-1)](1+\gamma)v}{c}\left(\frac{4\frac{[1+\alpha(n_W-1)]}{[1+\alpha(n_S-1)]}+\left(1+\frac{[1+\alpha(n_W-1)]}{[1+\alpha(n_S-1)]}\right)^2}{8\left(1+\frac{[1+\alpha(n_W-1)]}{[1+\alpha(n_S-1)]}\right)^2}\right)$ $X_W^{**} = \frac{[1+\alpha(n_W-1)](1+\gamma)v}{c}\left(\frac{4\frac{[1+\alpha(n_W-1)]}{[1+\alpha(n_S-1)]}+\left(1+\frac{[1+\alpha(n_W-1)]}{[1+\alpha(n_S-1)]}\right)^2}{8\left(1+\frac{[1+\alpha(n_W-1)]}{[1+\alpha(n_S-1)]}\right)^2}\right)$

Notes: The equilibrium effort of strong and weak teams are denoted by X_S^{**} and X_W^{**}, respectively. A strong team has either a lower cost of effort (i.e., $c_S < c_W$), higher prize value ($v_S > v_W$), or larger group size (i.e., $n_S > n_W$) relative to the weak team. Equilibria correspond with $r = \frac{1}{2}$, i.e., that there is a 50% chance the opponent is a strong team.

Proofs of propositions for $\boldsymbol{r = \frac{1}{2}}$

Propositions 1 to 3 are based on a standard theory of self-interest. As demonstrated above, the extended theory equilibria are equal to the equilibria from the standard self-interest model multiplied by a scale factor that does not vary by information condition. For parsimony, here we prove Propositions 1 and 3 for the extended model in the case of cost-of-effort heterogeneity when $r = \frac{1}{2}$. Parallel proofs for other sources of heterogeneity (including the case of group size heterogeneity with $\alpha = 0$) follow in a straightforward way. For convenience, throughout this appendix we define $\tilde{n} \equiv [1 + \alpha(n-1)] \cdot (1+\gamma)$. The standard self-interest theory arises when $\alpha = 0$ and $\gamma = 0$, in which case $\tilde{n} = 1$ and the in-group altruism model arises when $\gamma = 0$.

Proof of Proposition 1(a): We claim that expected contest-level effort in an incomplete information contest is higher than in an uneven contest. In incomplete information contest, the actual type of the opponent is irrelevant as it does not alter effort. Therefore, when there is a 50% chance that a team is strong, contest-level effort is equal to group effort from one strong and one weak team. An uneven contest, with probability 1, is a contest between a strong and a weak team. Using the solutions provided in Tables A.1 and A.2, we then need to show:

$$\text{[A.7]} \quad \frac{\tilde{n}v}{c_S}\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right)+\frac{\tilde{n}v}{c_W}\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right) > \frac{c_W v\tilde{n}}{(c_S+c_W)^2}+\frac{c_S v\tilde{n}}{(c_S+c_W)^2}\,.$$

Combining terms, and dividing both sides by $v\tilde{n}$ yields:

$$\text{[A.8]} \quad \left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\frac{c_S}{c_W}}\right)\frac{c_S+c_W}{(c_S+c_W)^2} > \frac{c_S+c_W}{(c_S+c_W)^2}\,.$$

Dividing both sides by $\frac{c_S+c_W}{(c_S+c_W)^2}$ yields:

[A.9] $\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\frac{c_S}{c_W}} > 1$,

which simplifies to:

[A.10] $\frac{1}{2}+\frac{\left(\frac{c_S+c_W}{c_W}\right)^2}{8\frac{c_S}{c_W}} > 1.$

Subtracting ½ from both sides, and then multiplying both sides by $8c_S c_W$ we obtain

[A.11] $(c_S + c_W)^2 > 4c_S c_W$.

Finally, this inequality simplifies to

[A.12] $(c_S - c_W)^2 > 0,$

which holds true for any $c_S < c_W$.

<u>Proof of Proposition 1(b)</u>**:** We claim that expected contest-level effort in an incomplete information contest is lower than in an even contest. Using the solutions provided in Tables A.1 and A.2, we then need to show that:

[A.13] $\frac{\tilde{n}v}{c_S}\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right)+\frac{\tilde{n}v}{c_W}\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right) < \frac{1}{2}\left(\frac{v\tilde{n}}{4c_S}+\frac{v\tilde{n}}{4c_S}\right)+\frac{1}{2}\left(\frac{v\tilde{n}}{4c_W}+\frac{v\tilde{n}}{4c_W}\right).$

Here, the r.h.s. is the contest-level effort from an even contest between two strong teams, and the contest-level effort from an even contest between two weak teams, each weighted by 50%. Cancelling terms on both sides, we are left with the following condition:

[A.14] $\left(\frac{4\frac{c_S}{c_W}+\left(1+\frac{c_S}{c_W}\right)^2}{8\left(1+\frac{c_S}{c_W}\right)^2}\right) < \frac{1}{4}$.

Expanding the l.h.s. of [A.14], and simplifying, we obtain

[A.15] $\frac{\frac{c_S}{c_W}}{2\left(1+\frac{c_S}{c_W}\right)^2}+\frac{1}{8}<\frac{1}{4}$.

Subtracting 1/8 from both sides, and then multiplying both sides by 2 yields:

[A.16] $\frac{\frac{c_S}{c_W}}{\left(1+\frac{c_S}{c_W}\right)^2}<\frac{1}{4}$.

The l.h.s. of [A.16] equals ¼ in the case where $c_S = c_W$, but is strictly less than ¼ for any $c_S < c_W$.

Proof of Proposition 3: We claim that expected contest-level effort for a contest with incomplete information is the same as for the average complete information contest when $r = \frac{1}{2}$. When $r = \frac{1}{2}$, there is a 50% chance of an uneven contest, a 25% chance of an even contest among weak teams, and a 25% chance of an even contest between strong teams. Using the equilibria presented in Table A.1, expected contest-level effort under complete information is:

[A.17] $\frac{1}{2}\left[\frac{c_W v\tilde{n}}{(c_S+c_W)^2}+\frac{c_S v\tilde{n}}{(c_S+c_W)^2}\right]+\frac{1}{4}\left(\frac{v\tilde{n}}{4c_S}+\frac{v\tilde{n}}{4c_S}\right)+\frac{1}{4}\left(\frac{v\tilde{n}}{4c_W}+\frac{v\tilde{n}}{4c_W}\right)$.

Rearranging terms,

[A.18] $\frac{1}{2}\left[\left(\frac{c_W v\tilde{n}}{(c_S+c_W)^2}\right)+\left(\frac{v\tilde{n}}{4c_S}\right)\right]+\frac{1}{2}\left[\left(\frac{c_S v\tilde{n}}{(c_S+c_W)^2}\right)+\left(\frac{v\tilde{n}}{4c_W}\right)\right]$.

Simplifying further and combining terms,

[A.19] $\frac{v\tilde{n}}{2}\left[\frac{4c_S c_W+(c_S+c_W)^2}{4c_S(c_S+c_W)^2}\right]+\frac{v\tilde{n}}{2}\left[\frac{4c_S c_W+(c_S+c_W)^2}{4c_W(c_S+c_W)^2}\right]$.

Last, multiplying the numerator and denominator of both bracketed terms by $1/c_W^2$, and simplifying, yields:

[A.20] $\frac{v\tilde{n}}{c_S}\left[\frac{4\frac{c_S}{c_W}+(1+\frac{c_S}{c_W})^2}{8(1+\frac{c_S}{c_W})^2}\right]+\frac{v\tilde{n}}{c_W}\left[\frac{4\frac{c_S}{c_W}+(1+\frac{c_S}{c_W})^2}{8(1+\frac{c_S}{c_W})^2}\right]$.

This expected effort is identical to that from an incomplete information contest.

General solution for group contest with $\boldsymbol{0 < r < 1}$

Below we derive the closed-form solution for the case of cost-of-effort heterogeneity and $0 < r < 1$. Other cases follow in a similar fashion. First, beginning with the first order condition defined by equation [A.5], if $g = D$, $n_S = n_W = n$, and $v_S = v_W = v$, then

[A.21] $\{(1-r)(X_W + X_S)^2 + 4rX_SX_W\}v\tilde{n} = 4X_Wc_W(X_W + X_S)^2$.

In a similar vein, if $g = A$, $n_S = n_W = n$, and $v_S = v_W = v$ it follows that

[A.22] $\{4(1-r)X_SX_W + r(X_W + X_S)^2\}v\tilde{n} = 4X_Sc_S(X_W + X_S)^2$.

This gives us two equations and two unknowns. Dividing [A.21] by [A.22], and rearranging yields:

[A.23] $X_S = \frac{(1-r)}{r}\frac{c_W}{c_S}X_W - \frac{(1-2r)}{r}\frac{v\tilde{n}}{4c_S}$.

In the special case of $r = \frac{1}{2}$, the second term equals 0 and this yields the simple relationship $X_S = \frac{c_W}{c_S}X_W$. For convenience, let $\delta = \frac{(1-r)}{r}\frac{c_W}{c_S}$ and $\theta = \frac{(2r-1)}{r}\frac{1}{4c_S}$, in which case [A.23] can be written as

[A.24] $X_S = \delta X_W + v\tilde{n}\theta$.

Now, substitute [A.24] into [A.21] to eliminate X_S:

[A.25] $\{(1-r)(X_W + \delta X_W + v\tilde{n}\theta)^2 + 4r(\delta X_W + v\tilde{n}\theta)X_W\}v\tilde{n} = 4X_Wc_W(X_W + \delta X_W + v\tilde{n})^2$

Rearranging and combining terms in [A.25], we obtain the following cubic equation

[A.26] $aX_W^3 + bX_W^2 + cX_W + d = 0$, where, $a = c_W(\delta+1)^2$, $b = v\tilde{n}\left(2c_W(\delta+1)\theta - r\delta - \frac{1}{4}(1-r)(\delta+1)^2\right)$, $c = (v\tilde{n})^2\left(c_W\theta^2 - r\theta - \frac{1}{2}(1-r)(\delta+1)\theta\right)$ and $d = -\frac{1}{4}(v\tilde{n})^3(1-r)\theta^2$. Last, dividing through by the coefficient a yields

[A.27] $X_W^3 + a_1 X_W^2 + a_2 X_W + a_3 = 0$,

where $a_1 = \frac{b}{a}$, $a_2 = \frac{c}{a}$ and $a_3 = \frac{d}{a}$. Applying established methods for solving a cubic equation (i.e., using a variant of Cardano's formula), the equation [A.27] has three real roots when $r \neq \frac{1}{2}$. The one root that satisfies the first-order condition of the maximization problem is:

[A.28] $X_W = 2\sqrt{-Q}\cos\left(\frac{1}{3}\vartheta\right) - \frac{1}{3}a_1$ and $X_S = \delta\left(2\sqrt{-Q}\cos\frac{1}{3}\vartheta - \frac{1}{3}a_1\right) + v\tilde{N}\theta$

where, $Q = \frac{3a_2 - a_1^2}{9}$, $R = \frac{9a_1a_2 - 27a_3 - 2a_1^3}{54}$, and $\vartheta = \arccos\left(\frac{R}{\sqrt{-Q^3}}\right)$. In the case of $r = \frac{1}{2}$, there are two real roots, but only one of them is non-zero. The solution in this case is:

[A.29] $X_W = 2R^{1/3} - \frac{1}{3}a_1$ and $X_S = \delta\left(2R^{1/3} - \frac{1}{3}a_1\right) + v\tilde{n}\theta$.

Here, $R^{1/3} = -a_1/3$, and it follows that $X_W = -a_1$ which simplifies to the formulas presented in Table A.2.

Support of Propositions for $0 < r < 1$

As mentioned earlier in the theory section, relative to an uneven contest, incomplete information increases contest-level effort, and that the effect is increasing in r and extent of the advantage. Note that for a strong team, effort is increasing under incomplete information for any r. However, for the weak team, in general, the effect is ambiguous and depends upon the extent of the advantage together with the probability that the other team is strong. When the advantage is relatively small, the discouragement effect discussed previously is also small. Then only for very high r does incomplete information motivate lower effort. As the size of the advantage increases, however, the range of probabilities for which incomplete information discourages effort increases. Overall, the effect of incomplete information on the strong team unambiguously dominates its effect on the weak team and so more generally the contest-level effort is increasing under incomplete information.

Relative to an even contests, incomplete information decreases group-level effort. With incomplete information, a team does not know the opposing team's type. A strong team will only suspect they are playing another strong team with some probability less than 1, and as a result will be incentivized to put forth less effort relative to the case where the opponent is for sure strong. A weak team will suspect their opponent may be strong, and this also lowers effort relative to the case where they know for sure the opponent is weak. This is due to the discouragement effect.

When considering contest-level effort, unconditional on contest type, the differential effects of incomplete information across uneven and even contests of course will counteract. When the probability a team is strong is exactly 50%, there is no difference in expected effort between contests with complete and incomplete information. But, as the (negative) effect of incomplete effort in even contests between two weak teams is relatively small, for $r < 1/2$ it is the case that expected effort is higher with incomplete information. This is because for $r < 1/2$ the positive effect in uneven contests dominates the negative effect in even (weak) contests. The opposite is true when conditions make it more probable that the contest is between two strong teams, i.e., when $r > 1/2$. Although the effects on expected effort (unconditional on contest type) are in general ambiguous, differences are relatively small.

As illustrated in Tables A.1 and A.2, under cost heterogeneity, the solutions for both the complete and incomplete information settings can be written as $X_g^{**} = v\tilde{n} \cdot f_g$, where the argument

f_g is not a function of the altruism, non-monetary utility of winning, group size and prize value parameters. As a result, these parameters do not independently determine differences in effort across the information conditions. This remains true in the general case.[1] As such, any differences based on information condition depend on the extent of the cost advantage and r. Without loss of generality, we can normalize $c_W \equiv 1$ in which case $0 < c_S < 1$ and the size of the advantage is decreasing in c_S. It then suffices to show that the propositions hold for all possible combinations of c_S and r.

Figures A.1 to A.3 are surface plots of the expected contest-level effort in the incomplete information case minus an uneven contest, the average even contest, and expected contest-level effort under complete information (i.e., a weighted average of uneven and even contests), respectively, for the case of cost heterogeneity. These are based on $\tilde{n} = 3$ and $v = 50$. Figure A.1 corresponds to uneven contests, and is thus relevant for Proposition 1(a). The effort difference is positive for any c_S and r, and is strictly increasing in both the size of the cost advantage and the probability the opponent is a strong team. Figure A.2 confirms Proposition 1(b) in the general case, specifically that contest level effort is lower with incomplete information relative to the average even contest.

Figure A.3 depicts differences in expected contest-level effort between the two information conditions. To be clear, this differs from the information provided in Figures A.1 to A.2 as effort under complete information is *un*conditional on contest type (i.e., even or uneven). When $r = 1/2$, there is no difference in contest-level effort as proven analytically. As r deviates from this value,

[1] To see this, note that we can write $Q = (v\tilde{n})^2 \cdot f_1$, $a_1 = v\tilde{n} \cdot f_2$, and $R = (v\tilde{n})^3 \cdot f_3$, where f_1, f_2, and f_3 are functions that do not contain v or $\tilde{n}$. Then, [A.28] becomes $X_W = v\tilde{n}\left(2\sqrt{-f_1}\cos\left(\frac{1}{3}\arccos\left(\frac{f_3}{\sqrt{-f_1^3}}\right)\right) - \frac{1}{3}f_2\right)$.

differences in expected effort arise due to information conditions but in general these differences are small when compared with the differences that arise from uneven contests and the average even contest. The largest differences occur when $c_S \to 0$.

Deviating from $r = 1/2$ in either direction increases the probability of an even contest. When $r > 1/2$ and it becomes more likely that an even contest between strong teams will occur, overall effort is higher with complete information. On the other hand, when $r < 1/2$ and it becomes more likely that an even contest between two weak teams will occur, expected effort is higher with incomplete information. Holding c_S fixed, the largest differences do not necessarily occur as r approaches 1 or 0 as there are competing effects. For instance, with $r > 1/2$, while increasing r does increase the chance of an even contest between strong teams, as a countervailing effect the difference in effort for an uneven contest under incomplete versus complete information is also increasing with r. The qualitative results from the simulations are consistent with the implications of Theorem 1 in Serena (2022).

Figure A.1 Differences in expected contest-level efforts: incomplete information relative to an uneven contest

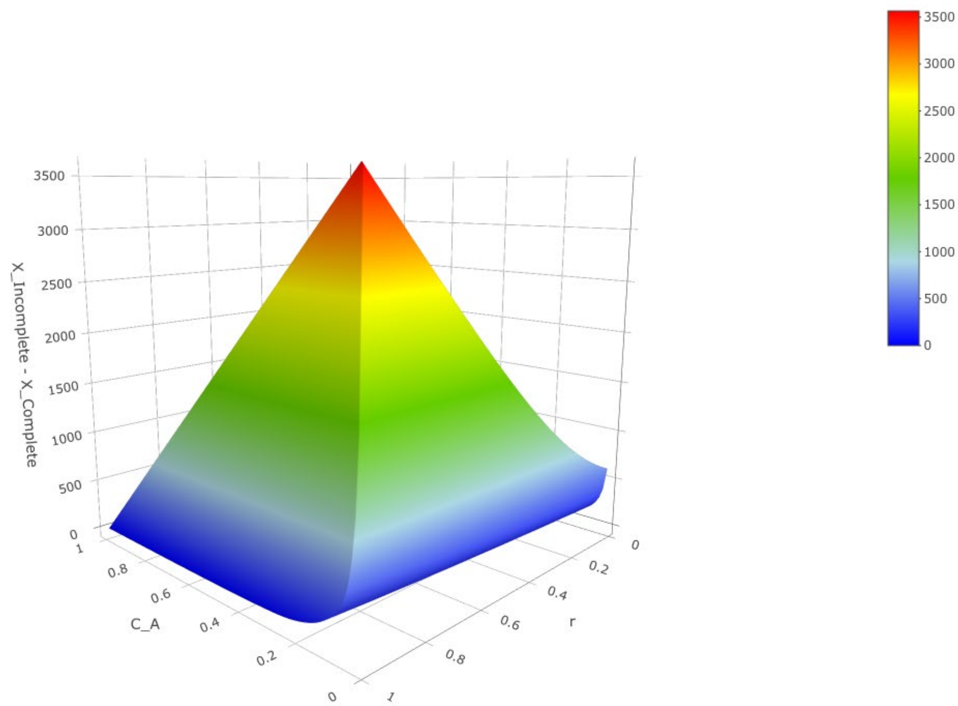


Figure A.2 Differences in expected contest-level effort: incomplete information relative to an even contest

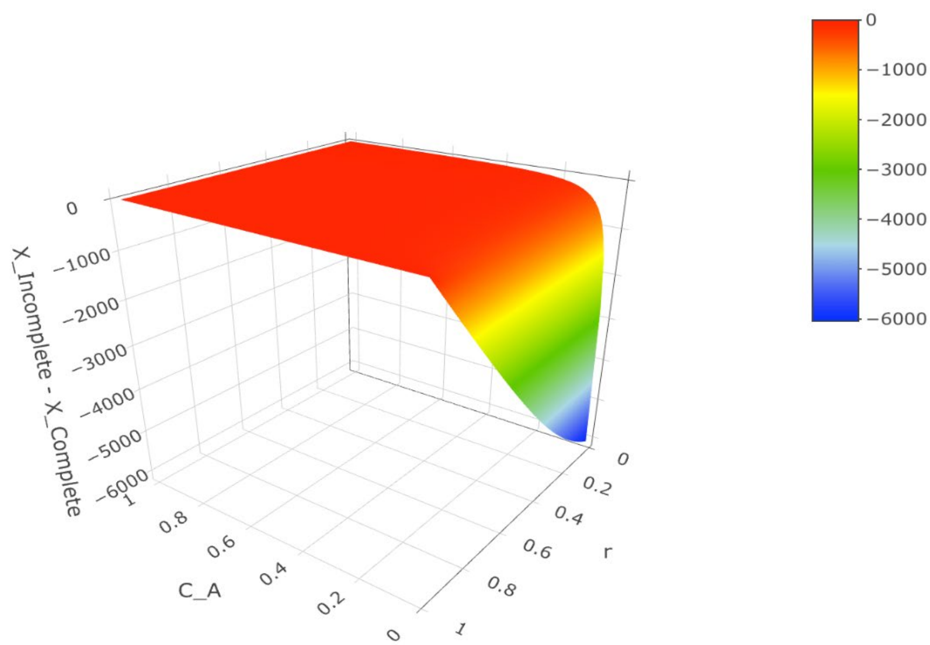
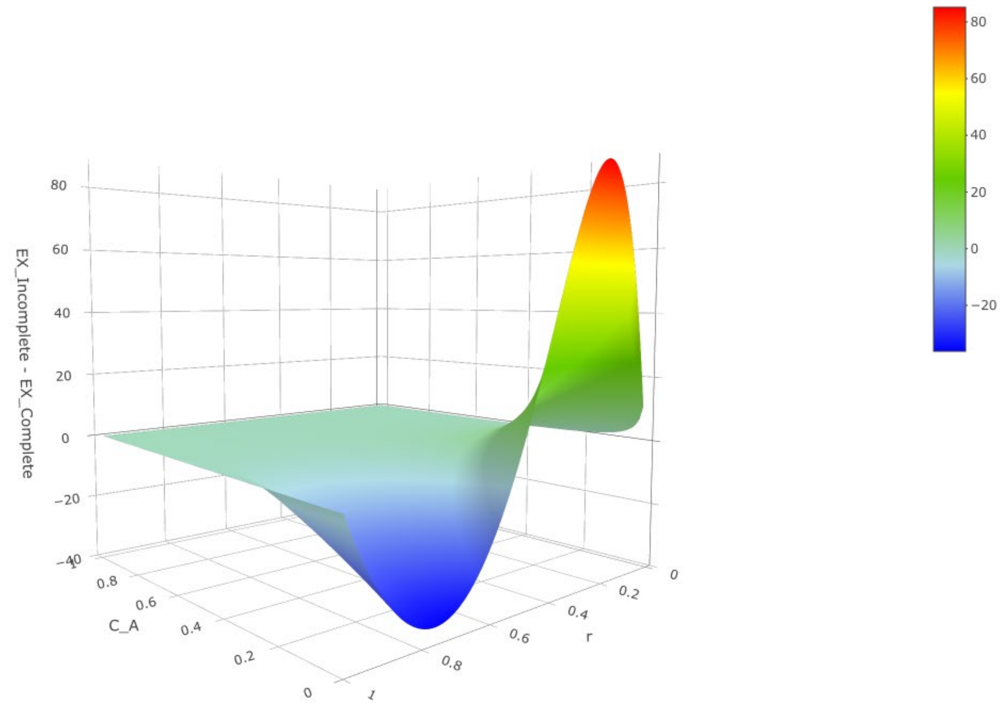


Figure A.3 Differences in expected contest-level efforts: incomplete information relative to complete information



Comparative static for change in group size, n_g

For simplicity, assume $\alpha = 1, \gamma = 0$. For the special cases of cost and value heterogeneity, it follows quite easily that the first derivate w.r.t. n_g is positive [see Table A.1]. For the special case of group size heterogeneity (uneven contests), assume, $c_g = c_{-g} = c$ and $v_g = v_{-g} = v$. As such, the closed form effort [A.3] simplifies to the following equation:

[A.30] $X_g^* = \frac{n_g^2 n_{-g} v}{c\{n_g+n_{-g}\}^2}$

Taking the first derivative w.r.t. n_g, we get,

[A.31] $\frac{\partial X_g^*}{\partial n_g} = \frac{2c\{n_g+n_{-g}\}^2 n_g\, n_{-g} v - 2n_g^2 n_{-g} v\, c\{n_g+n_{-g}\}}{c^2\{n_g+n_{-g}\}^4}$

Expanding terms,

[A.32] $\frac{\partial X_g^*}{\partial n_g} = \frac{2vc\{n_g+n_{-g}\}[\{n_g+n_{-g}\}n_g n_{-g} - n_g^2 n_{-g}]}{c^2\{n_g+n_{-g}\}^4}$

Simplifying and expanding further,

[A.33] $\frac{\partial X_g^*}{\partial n_g} = \frac{2v\,[n_{-g}^2 n_g]}{c\{n_g+n_{-g}\}^3} > 0.$

Therefore, as the group size n_g increases, so does the equilibrium group effort, X_g^*.

Appendix B: Additional econometric analysis

Table B.1 Analysis of group-level effort by contest type (pre-pandemic data)

Dependent variable: Group Effort			
	(1)	(2)	(3)
Value	-1.77	1.30	1.95
	(4.86)	(4.54)	(4.44)
Group	25.28***	29.48***	29.48***
	(6.37)	(5.96)	(5.07)
Cost × Incomplete	9.54**	18.31***	18.83***
	(4.76)	(4.22)	(3.96)
Value × Incomplete	13.69***	19.40***	19.24***
	(4.92)	(5.10)	(4.86)
Group × Incomplete	-7.69	-3.12	-2.37
	(7.48)	(7.47)	(5.45)
Cost × Even		17.54***	18.48***
		(4.13)	(4.24)
Value × Even		11.41***	11.13***
		(3.57)	(3.54)
Group × Even		9.14	9.90
		(7.55)	(6.73)
Cost × Decision Round			-1.15***
			(0.35)
Value × Decision Round			-0.76*
			(0.42)
Group × Decision Round			-2.72***
			(0.39)
Constant	56.34***	47.57***	47.08***
	(3.94)	(3.27)	(3.36)
Observations	1,848	1,848	1,848
R-squared	0.05	0.06	0.11

Notes: *** p<0.01, ** p<0.05, * p<0.1. Two-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. The covariate "Decision Round" is demeaned.

Table B.2 Analysis of group-level effort across strong and weak groups, by contest type (pre-pandemic data)

Dependent variable: Group Effort			
	Uneven	Even	Incomplete info.
Value	7.36**	-6.05	8.34*
	(3.52)	(5.97)	(4.83)
Group	22.00***	1.29	-8.75**
	(5.15)	(4.91)	(4.34)
Cost × Strong	54.94***	31.11***	45.66***
	(5.77)	(7.55)	(2.54)
Value × Strong	43.65***	32.76***	33.68***
	(2.80)	(3.93)	(3.85)
Group × Strong	69.43***	70.50***	79.73***
	(8.34)	(6.40)	(7.31)
Cost × Decision Round	-0.49	-0.84	-1.06***
	(0.50)	(0.63)	(0.33)
Value × Decision Round	-1.01*	-0.37	-0.85
	(0.51)	(0.57)	(0.64)
Group × Decision Round	-2.42***	-2.39***	-2.74***
	(0.69)	(0.49)	(0.37)
Constant	19.89***	49.89***	43.08***
	(2.20)	(4.50)	(2.26)
Observations	394	450	1,004
R-squared	0.56	0.43	0.49

Notes: *** p<0.01, ** p<0.05, * p<0.1. Two-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. The covariate "Decision Round" is demeaned.

Table B.3 Analysis of individual effort by contest type

	Dependent variable: Individual Effort			
	(1)	(2)	(3)	(4)
Value	-0.59	0.43	0.31	0.24
	(2.48)	(2.28)	(2.17)	(2.16)
Group	-4.57**	-2.46	-3.68*	-3.91*
	(2.19)	(2.14)	(2.07)	(2.08)
Cost × Incomplete	3.18	6.10***	6.34***	6.15***
	(2.35)	(2.18)	(2.07)	(2.08)
Value × Incomplete	4.56*	6.47**	6.40***	6.33***
	(2.57)	(2.54)	(2.32)	(2.28)
Group × Incomplete	-0.98	-0.16	1.14	1.24
	(1.73)	(1.87)	(1.67)	(1.67)
Cost × Even		5.85***	6.12***	5.95***
		(1.60)	(1.60)	(1.59)
Value × Even		3.80***	3.72***	3.70***
		(1.18)	(1.16)	(1.16)
Group × Even		1.64	2.22*	2.26*
		(1.16)	(1.27)	(1.26)
Cost × Decision Round			-0.38***	-0.38***
			(0.11)	(0.11)
Value × Decision Round			-0.25**	-0.25**
			(0.12)	(0.11)
Group × Decision Round			-0.35***	-0.35***
			(0.04)	(0.04)
Experience			-4.31***	-4.39***
			(1.10)	(1.10)
Risk Averse			-3.51***	-3.34***
			(1.14)	(1.12)
Female			2.19**	2.24**
			(1.04)	(1.03)
GPA			-1.99*	0.16
			(1.16)	(1.34)
GPA × Incomplete				-4.74**
				(2.16)
Constant	18.78***	15.86***	16.03***	16.19***
	(1.89)	(1.68)	(1.64)	(1.65)
Observations	7,200	7,200	7,200	7,200
R-squared	0.05	0.06	0.11	0.12

Notes: *** p<0.01, ** p<0.05, * p<0.1. Three-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. The covariate "Decision Round" is demeaned.

Table B.4 Analysis of individual effort across strong and weak groups, by contest type

	Uneven	Uneven	Even	Even	Incomplete Information	Incomplete Information
Value	2.32	1.92	-1.90	-2.30	3.07	2.46
	(1.90)	(1.86)	(2.70)	(2.54)	(2.60)	(2.33)
Group	7.01***	5.76***	0.83	-0.32	-0.74	-1.08
	(2.17)	(2.13)	(2.40)	(2.33)	(2.37)	(2.14)
Cost × Strong	18.31***	18.25***	10.45***	10.46***	15.59***	15.36***
	(2.22)	(2.27)	(2.46)	(2.60)	(1.46)	(1.45)
Value × Strong	14.55***	14.75***	11.04***	11.24***	11.05***	11.35***
	(1.97)	(1.90)	(1.53)	(1.36)	(1.71)	(1.69)
Group × Strong	-0.43	-0.18	-3.03***	-2.66**	-0.25	-0.26
	(2.15)	(2.18)	(1.11)	(1.13)	(1.56)	(1.55)
Cost × Decision Round		-0.17		(1.47)		-0.35***
		(0.17)		-0.29		(0.09)
Value × Decision Round		-0.35**		(0.20)		-0.28*
		(0.16)		-0.13		(0.17)
Group × Decision Round		-0.32***		(0.14)		-0.41***
		(0.08)		-0.23*		(0.02)
Experience		-1.83		-4.52***		-5.15***
		(1.67)		(1.68)		(1.57)
Risk Averse		-5.61***		-3.55*		-2.51
		(1.64)		(1.81)		(1.56)
Female		2.37		1.15		2.24
		(1.60)		(1.65)		(1.42)
GPA		-0.70		0.48		-5.20***
		(1.38)		(1.47)		(1.73)
Constant	6.70***	7.26***	16.48***	17.00***	14.16***	14.46***
	(1.13)	(1.12)	(1.98)	(1.94)	(1.56)	(1.40)
Observations	1,602	1,602	1,758	1,758	3,840	3,840
R-squared	0.16	0.22	0.11	0.16	0.18	0.26

Notes: *** p<0.01, ** p<0.05, * p<0.1. Three-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. Control variables are demeaned.

Table B.5 Analysis of individual effort by contest type (Tobit)

	Dependent variable: Individual Effort			
	(1)	(2)	(3)	(4)
Value	-0.75	0.76	0.63	0.52
	(2.63)	(2.78)	(2.67)	(2.65)
Group	-4.94**	-2.32	-3.99	-4.26
	(2.33)	(2.73)	(2.62)	(2.62)
Cost × Incomplete	4.17*	8.35***	8.59***	8.34***
	(2.34)	(2.49)	(2.41)	(2.42)
Value × Incomplete	5.92**	8.59***	8.41***	8.32***
	(2.66)	(2.68)	(2.56)	(2.53)
Group × Incomplete	-1.78	-0.21	1.37	1.47
	(2.29)	(2.55)	(2.39)	(2.37)
Cost × Even		8.18***	8.45***	8.22***
		(1.89)	(1.83)	(1.82)
Value × Even		5.27***	5.14***	5.10***
		(1.19)	(1.18)	(1.20)
Group × Even		3.08*	3.89**	3.94**
		(1.58)	(1.65)	(1.64)
Cost × Decision Round			-0.47***	-0.47***
			(0.09)	(0.09)
Value × Decision Round			-0.32***	-0.32***
			(0.07)	(0.08)
Group × Decision Round			-0.48***	-0.48***
			(0.06)	(0.06)
Experience			-5.42***	-5.51***
			(1.35)	(1.34)
Risk Averse			-4.37***	-4.14***
			(1.39)	(1.38)
Female			3.10**	3.16**
			(1.31)	(1.30)
GPA			-2.30	0.53
			(1.47)	(1.87)
GPA × Incomplete				-6.18**
				(2.74)
Constant	16.46***	12.28***	12.57***	12.79***
	(1.86)	(2.04)	(1.94)	(1.94)
Observations	7,200	7,200	7,200	7,200
Pseudo-R2	0.01	0.01	0.02	0.02

Notes: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses (clustered by participant). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. Control variables are demeaned. Lower limit imposed at 0.

Table B.6 Analysis of individual effort across strong and weak groups (Tobit)

Dependent variable: Individual effort			
	Uneven	Even	Incomplete Information
Value	4.13	-3.03	2.70
	(3.33)	(2.85)	(2.54)
Group	9.23***	-0.21	-2.87
	(3.53)	(2.64)	(2.74)
Cost × Strong	25.55***	11.68***	16.96***
	(2.50)	(1.95)	(1.72)
Value × Strong	19.29***	12.90***	12.69***
	(2.96)	(1.71)	(1.59)
Group × Strong	1.02	-2.90**	0.54
	(3.11)	(1.43)	(1.96)
Cost × Decision Round	-0.24	-0.40**	-0.43***
	(0.17)	(0.19)	(0.10)
Value × Decision Round	-0.53***	-0.17	-0.31***
	(0.16)	(0.12)	(0.09)
Group × Decision Round	-0.50***	-0.31**	-0.52***
	(0.12)	(0.13)	(0.08)
Experience	-2.39	-5.37***	-6.45***
	(2.17)	(1.94)	(1.86)
Risk Averse	-7.04***	-4.06**	-3.26*
	(2.21)	(1.99)	(1.92)
Female	3.67	1.28	3.28*
	(2.23)	(1.98)	(1.74)
GPA	-0.73	0.90	-6.31***
	(2.07)	(1.95)	(2.07)
Constant	-0.77	15.33***	12.41***
	(2.35)	(2.08)	(1.69)
Observations	1,602	1,758	3,840
Pseudo-R2	0.04	0.02	0.04

Notes: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses (clustered by participant). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. Control variables are demeaned. Lower limit imposed at 0.

Table B.7 Analysis of group-level effort, by contest type (last 10 rounds)

Dependent variable: Group Effort			
	(1)	(2)	(3)
Value	-1.62	-2.70	-2.39
	(6.33)	(5.16)	(4.94)
Group	25.29***	26.76***	27.27***
	(8.09)	(6.33)	(5.57)
Cost × Incomplete	14.88**	21.20***	21.45***
	(6.58)	(5.57)	(5.16)
Value × Incomplete	12.47*	19.87***	19.97***
	(6.34)	(6.25)	(6.34)
Group × Incomplete	-10.97	-6.13	-6.13
	(8.18)	(7.34)	(6.43)
Cost × Even		12.64***	13.23***
		(4.50)	(4.85)
Value × Even		14.78***	14.99***
		(4.13)	(4.19)
Group × Even		9.70	9.48
		(6.39)	(6.53)
Cost × Decision Round			-1.63*
			(0.95)
Value × Decision Round			0.36
			(0.96)
Group × Decision Round			-2.77**
			(1.19)
Constant	53.06***	46.74***	46.34***
	(5.50)	(4.24)	(3.97)
Observations	990	990	990
R-squared	0.05	0.06	0.08

Notes: *** p<0.01, ** p<0.05, * p<0.1. Two-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. The covariate "Decision Round" is demeaned.

Table B.8 Analysis of group-level effort across strong and weak groups, by contest type (last 10 rounds)

Dependent variable: Group Effort			
	Uneven	Even	Incomplete info.
Value	3.27	-3.76	13.68*
	(3.56)	(9.63)	(7.29)
Group	21.91***	-1.38	1.97
	(6.03)	(7.62)	(4.64)
Cost × Strong	55.85***	28.87***	52.39***
	(6.89)	(10.46)	(2.53)
Value × Strong	44.70***	34.62***	30.36***
	(4.30)	(6.00)	(5.76)
Group × Strong	66.84***	79.25***	60.88***
	(11.00)	(10.41)	(6.01)
Cost × Decision Round	-1.94*	0.01	-0.95
	(0.99)	(2.46)	(0.89)
Value × Decision Round	0.33	-1.09	-0.04
	(1.06)	(1.51)	(1.78)
Group × Decision Round	-4.25***	-0.16	-2.26
	(1.10)	(1.79)	(1.53)
Constant	18.34***	44.95***	35.05***
	(2.50)	(7.30)	(2.59)
Observations	202	248	540
R-squared	0.59	0.42	0.43

Notes: *** p<0.01, ** p<0.05, * p<0.1. Two-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. The covariate "Decision Round" is demeaned.

Table B.9 Analysis of probability of winning in uneven contests

Dependent variable: Probability of Winning		
	Complete Information	Incomplete Information
Value	5.855**	4.813*
	(2.256)	(2.467)
Group	4.795*	-8.401***
	(2.447)	(2.725)
Cost × Strong	60.481***	34.278***
	(3.569)	(3.182)
Value × Strong	48.771***	24.729***
	(2.760)	(3.830)
Group × Strong	50.891***	51.140***
	(3.347)	(4.472)
Cost × Decision Round	-0.000	-0.060***
	(0.000)	(0.017)
Value × Decision Round	0.000	0.003
	(0.000)	(0.006)
Group × Decision Round	0.000***	0.022
	(0.000)	(0.079)
Constant	19.759***	32.822***
	(1.785)	(1.555)
Observations	422	482
R-squared	0.73	0.61

Notes: *** p<0.01, ** p<0.05, * p<0.1. Two-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. The covariate "Decision Round" is demeaned. Incomplete information sample only includes groups that, unknown to them, competed in an uneven content.

Table B.10 Free-riding behavior (Probit model)

Dependent variable: Zero effort		
	Coefficients	Marginal Effects
Group	-0.153	-0.040
	(0.158)	(0.041)
Incomplete	-0.659***	-0.171***
	(0.132)	(0.033)
Group × Incomplete	0.558***	0.145***
	(0.213)	(0.055)
Strong	-0.765***	-0.198***
	(0.090)	(0.022)
Group × Strong	0.585***	0.152***
	(0.124)	(0.032)
Even	-0.528***	-0.137***
	(0.086)	(0.022)
Group × Even	0.117	0.030
	(0.163)	(0.042)
Decision Round	0.028***	0.007***
	(0.004)	(0.001)
Experience	0.271**	0.070***
	(0.106)	(0.027)
Risk Averse	0.248**	0.064**
	(0.104)	(0.027)
Female	-0.254**	-0.066**
	(0.101)	(0.026)
GPA	0.090	0.023
	(0.130)	(0.034)
Constant	-0.958**	
	(0.446)	
Observations	7,200	
R-squared	0.102	

Notes: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses (clustered by participant). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types.

Table B.11 Analysis of individual effort: behavioral dynamics

	Dependent variable: Individual effort	
	Prior Loss	Prior Group Effort
Group	3.496*	1.120
	(1.785)	(1.813)
Incomplete	6.546***	4.487***
	(1.546)	(1.581)
Group × Incomplete	-5.373**	-4.537**
	(2.265)	(2.140)
Strong	13.723***	13.653***
	(0.850)	(0.841)
Group × Strong	-14.316***	-14.548***
	(1.355)	(1.360)
Even	5.577***	4.049***
	(1.005)	(1.093)
Group × Even	-2.805*	-3.375**
	(1.542)	(1.577)
$Loss_{t-1}$	-0.440	
	(0.669)	
Incomplete × $Loss_{t-1}$	-0.370	
	(0.791)	
Even × $Loss_{t-1}$	-1.440	
	(0.875)	
Group $Effort_{t-1}$		0.065***
		(0.011)
Incomplete × Group $Effort_{t-1}$		0.014
		(0.016)
Even × Group $Effort_{t-1}$		0.011
		(0.013)
Constant	23.696***	17.813***
	(4.141)	(3.896)
Observations	6,840	6,840
R-squared	0.22	0.26

Notes: *** p<0.01, ** p<0.05, * p<0.1. Three-way clustered standard errors are in parentheses (see text for details). The regressions utilize sampling weights to adjust for unequal randomization into contest and group types. Both regressions include control variables, but coefficient estimates are omitted for brevity.

Appendix C: Experiment instructions and post-experiment questionnaire

Instructions for cost treatment with incomplete information

Thank you for participating in today's study. Please follow the instructions carefully. At any time, please feel free to raise your hand if you have a question.

You have been randomly assigned an ID number for this session. You will make decisions using a computer. You will never be asked to reveal your identity to anyone. Your name will never be associated with any of your decisions. In order to keep your decisions private, please do not reveal your choices or otherwise communicate with any other participant. Importantly, please refrain from verbally reacting to events that occur.

Today's session has three parts: Experiment 1, Experiment 2, and a short questionnaire. You will have the opportunity to earn money in both experiments based on your decisions. You will be paid your earnings privately, and in cash, at the end of the experiment session. We will proceed through the written materials together. Please do not enter any decisions on the computer until instructed to do so.

Are there any questions before we begin?

Please go ahead and click "Continue" to enter the experiment.

Experiment 1

Please click "Continue" and refer to your computer screen while we read the instructions.

We would like you to make a decision for each of 10 scenarios. Each scenario involves a choice between playing a lottery that pays $4 or $0 according to specified chances (Option A) or receiving $2 for sure (Option B).

You will notice that the only differences across scenarios are the chances of receiving the high or low prize for the lottery. At the end of the today's session, **<u>ONE</u>** of the 10 scenarios will be selected at random and you will be paid according to your decision for this selected scenario **<u>ONLY</u>**. Each scenario has an equal chance of being selected.

Please consider your choice for each scenario carefully. Since you do not know which scenario will be played out, it is in your best interest to treat each scenario as if it will be the one used to determine your earnings.

Before making decisions, are there any questions?

Once you are ready to submit your decisions, please click the "Submit" button.

Experiment 2

In this experiment, all money amounts are denominated in lab dollars, and will be exchanged at a rate of **90** lab dollars to 1 US dollar at the end of the experiment.

There will be many decision rounds in the experiment. You will not know the number of rounds until the experiment has been completed. Each decision round is separate from the other rounds, in the sense that the decisions you make in one round will not affect the outcome or earnings of any other round.

In each round, participants will be randomly placed into three-person groups.

In each decision round, your group will compete with one other group to determine which group wins a **prize** of 150 lab dollars. This prize will be evenly divided among all group members. If your group wins the prize, you will personally receive 150/3 or 50 lab dollars.

Your task in each decision round is to **decide how many points to contribute towards a group project.** Which group wins the prize depends upon the total contributions from your group *relative* to the total contributions of the opponent group. The chance your group wins the prize is determined by the following formula:

$$\text{Chance of winning} = \frac{\text{Total contributions (Your group)}}{\text{Total contributions (Your group)} + \text{Total contributions (Opponent)}} \times 100\%$$

Using this formula:

- If the total contributions from both groups are *equal*, then both groups have an *equal* chance of winning the prize; i.e., the chance each group wins the prize is 50%.
- If your group contributes *more* than your opponent, then your group has a higher chance of winning the prize. For example, if your group contributes twice as much, the chance your group wins the prize is 2 in 3 or 66.7%.
- If your group contributes *less* than your opponent, then your group has a lower chance of winning the prize. For example, if the opponent group contributes four times as much as your group, your group has a 1 in 5 or 20% chance to win.

You can contribute anywhere from **0 to 50 points** (only in integer amounts) towards the group project.

While increasing contributions will increase the chance your team wins the prize, contributing points costs money. In particular, each point you contribute is associated with a per-point **contribution cost**.

The per-point **contribution cost** can have two values: either 1/3 of a lab dollar or 1 lab dollar. You will know the contribution cost when deciding.

In each round, you will receive 50 lab dollars in **fixed income.** This amount does not depend on your decision or whether your group wins this prize. Your earnings for the decision round will be calculated as follows:

IF your group wins…	Your Earnings = 100 – (points YOU contributed * contribution cost)
IF your group does not win…	Your Earnings = 50 – (points YOU contributed * contribution cost)

Before we continue, are there any questions?

Instructions quiz

At this time, we would like you to answer a few questions to help you understand how the experiment works. The good news is that you will be paid for correct answers. You may wish to first answer these using pen and paper. When you are ready, please read the instructions on your computer carefully, and click "I understand, Continue to Quiz" to submit your answers on the computer. If you have a question when working through the quiz, please raise your hand and your question will be answered privately.

1. Suppose the contribution cost is 1/3 of a lab dollar per point. You contribute 18 points. Your group wins the prize. How much money would you earn for this decision round (in lab dollars)?
   a. 27 b. 44 c. 70 d. 94

2. If your group contributes a total of 60 points and the opponent group contributes a total of 100 points, what is the chance your group wins the prize?
   a. 62.5% b. 37.5% c. 0% d. 50%

3. Suppose the contribution cost is 1 lab dollar per point. You contribute 40 points, and the total contributions from your group (including your own) are 50 points. Your group does not win the prize. How much money would you earn for this decision round (in lab dollars)?
   a. 30 b. –40 c. 10 d. 0

4. Suppose the other two members of your group contribute a total of 20 points. The opponent group contributes 20 points. Therefore, if you contribute nothing your group has a 50% chance of winning. By how much would you increase the chance your group wins if you contribute 10 points instead of contribute nothing?
   a. 0% b. 5% c. 60% d. 10%

Proceeding through the experiment

At the start of each round, you will be randomly matched into a group of three players. Your group will then be randomly matched with another group. This means that both the members of your own group as well as the members of the opponent group will vary from one round to the next.

At the start of each round, the computer will randomly determine the contribution cost for each group. Both groups will each have a 50% chance of facing the low or high contribution cost. This random determination is done independently for each group, which means that in some rounds your contribution cost will be the same as your opponent, and in other rounds it will be different. In particular:

- There will be a 25% chance that both your group and the group you are competing with have a low contribution cost (1/3 of a lab dollar);
- There will be a 25% chance that both groups have a high contribution cost (1 lab dollar); and,
- There will be a 50% chance that one group will have a low cost while the other has a high cost.

You will always know the contribution cost for your group. Throughout the experiment, however, you will <u>not</u> know the contribution cost for the opponent group.

Note: In the corresponding complete information treatment, the above two sentences are replaced with: "You will always know the contribution cost for your group and the opponent group."

Your **decision screen** will include relevant information for both your own group and the opponent group. Know that the <u>prize value</u> and <u>group size</u> will never change during the experiment.

At the end of each decision round you will be shown a **result screen** with the contest result, the total points contributed by all your group members, and your earnings.

We will begin with a training round to help you understand the procedures.

Aside from decisions in this training round, you will be paid based on the outcome of <u>each</u> decision round. This means that it is very important to consider each decision prior to making it.

Before we continue, do you have any questions?

Post-experiment questionnaire (computerized)

Part 1: About the Experiment

We would now like for you to complete a short questionnaire. Please know that all responses will be treated as strictly confidential and will be used for statistical purposes only. The first questions relate to your experience in today's experiment.

1. Have you previously participated in a paid study that took place in an experimental economics laboratory?
a. Yes b. No

2. Please indicate your level of agreement with the following statement: "I understood well the instructions for Experiment 2."
1 - Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 - Strongly Agree

3. Please indicate your level of agreement with the following statement: "I was well compensated for my participation in this study."
1 - Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 - Strongly Agree

4. In the past twelve months, approximately how much money (cash, check, credit card, etc.) did you donate to a charity or non-profit organization?

5. In the past twelve months, what is the approximate fair market value of non-cash property (clothing, appliances, etc.) you donated to a charity or non-profit organization?

6. In the past twelve months, approximately how many hours did you spend doing volunteer work for a charity or non-profit organization?

7. Many classes at the University of Tennessee require students to work on assignments in groups. In these settings, do you usually contribute less, about the same, or more than other people in your group?
a. Less b. About the same c. More

Please use the following space to write any comments (positive or negative) you may have about the experiment.

Part 2: Demographics

The next questions tell us something about you.
1. What is your age?
2. How do you describe yourself?
a. Male b. Female c. Transgender d. Do not identify myself as female, male, or transgender
3. What is your academic major?
4. What is your current student classification?
a. Freshman b. Sophomore c. Junior d. Senior e. Master's Student f. Law Student g. Doctoral Student h. Other
5. What was your student status for the Spring 2019 semester?

a. Full-time student b. Part-time student c. Not a student
6. In what range is your cumulative GPA?
a. 0 to 2.0 b. 2.1 to 2. c. 2.6 to 3.0 d. 3.1 to 3.5 e. 3.6 to 4.0
7. How many economics courses have you completed at the university level?

8. How would you best describe your current employment status?
a. Employed Full-Time b. Employed Part-Time c. Self-Employed Full-Time d. Self-Employed Part-Time e. Unemployed

Part 3: Personality
Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other. All questions below are to be rated from 1-7. 1 represents strongly disagree and 7 represents strongly agree.

I see myself as:
a. Extroverted, enthusiastic
b. Critical, quarrelsome
c. Dependable, self-disciplined
d. Anxious, easily upset
e. Open to new experiences, complex
f. Reserved, quiet
g. Sympathetic, warm
h. Disorganized, careless
i. Calm, emotionally stable
j. Conventional, uncreative