The Persistence of Disadvantages: Theory and Experiment

Nishtha Sharma*

Abstract

Many economic situations involve contests for resources, such as winning prizes and earning bonuses. The likelihood of success in such contests is often skewed, favouring some competitors while putting others at a disadvantage. I study the strategic interaction between an advantaged and a disadvantaged competitor in a repeated contest where winning can help overcome the initial disadvantage. Theoretically, both competitors increase their efforts, but the advantaged competitor increases effort more than the disadvantaged competitor. As a result, the disadvantaged competitor is even less likely to win when they have the potential to overcome their disadvantage, and the initial disadvantage is persistent. Evidence from a laboratory experiment supports these theoretical predictions.

Keywords: Contest, Disadvantage, Dynamic hierarchies, Laboratory Experiment
JEL Codes: C72, C73, C92, D63, D72, J15, J71

*New York University Abu Dhabi (email: nishtha.sharma@nyu.edu).
Acknowledgments - This paper has benefited from comments by John Duffy, Alex Imas, Rachel Kranton, Michael McBride, Maximilian Mihm, Ernesto Rueben, and Stergios Skaperdas. I am thankful for generous grants from the Center for Global Peace and Conflict Studies, the Initiative to End Family Violence Fellowship, the Kugelman Citizen Peacebuilding Research Fellowship, and the Department of Economics Graduate Student Fellowship at the University of California, Irvine.
The Institutional Review Board at the University of California, Irvine approved this project.

In competitive economic arenas, such as job markets, admissions processes, sports, and political races, certain participants face disadvantages that reduce their chances of success. These disadvantages can stem from causes such as lower ability or confidence, resource access, neighborhood or university affiliation, or identity-based discrimination. While it is widely believed that the initially disadvantaged competitors can work hard to level the playing field or even gain an advantage[1], underdog wins and advantage reversals remain rare occurrences. The initially advantaged individuals and entities tend to consistently thrive over extended periods in business, sports, politics, and labour markets (Bertrand and Duflo, 2017). In this paper, I use theory and experiment to examine why disadvantages persist even when they are not fixed, and the disadvantaged competitor can overcome them by initial success.

Consider two researchers, Alex and Betty competing for a prestigious grant. Assume that Alex is more likely to win the grant for a similar merit of application due to a more prestigious university affiliation. If Betty wins despite the disadvantage, creating a track record of winning grants can help her overcome it for future applications. The possibility of overcoming the disadvantage might encourage Betty to try harder to win the initial grant. However, it may also encourage Alex to resist losing his advantage and reduce Betty's chances of overcoming her disadvantage. I study such repeated contests in this paper and examine the behavior of advantaged and disadvantaged competitors to study the dynamics of disadvantages.

I model the competition between an advantaged player A and a disadvantaged player B as a two-period contest where both players' likelihood of winning increases in their relative contest expenditure or effort. Player A's effort is multiplied by a factor greater than one, so B has a lower chance of winning even if both players exert equal effort. I assume an exogenously given initial advantage in favor of A. It remains constant in the fixed disadvantage scenario. For the flexible disadvantage scenario, I examine the effect of both reducible (B's disadvantage reduces upon winning) and reversible disadvantages (B becomes advantaged in the second period upon winning in the first period). Flexible advantages can impact the players' effort choices in the initial period depending on how much they affect the structure of the second-period contest and how much the players care about their payoffs in the second period, i.e., their time preference for the future.

The model yields two main predictions. Firstly, when B can reduce or reverse their disadvantage by winning, both players exert more effort in the initial contest than when the disadvantage is fixed. Secondly, unless A has a sufficiently lower time preference

[1]For instance, the recent evidence on the dynamics of gender discrimination suggests that after overcoming initial prejudice, women may experience preferential treatment over men (Bohren et al., 2019; Mengel et al., 2019; Ayalew et al., 2018).

for the future than B, the increase in A's effort to preserve the advantage is greater than the increase in B's effort to overcome the disadvantage[2]. B exerts higher costly efforts under a flexible disadvantage and yet becomes even less likely to win in equilibrium than when the disadvantage is fixed. As a result, the initial inequality between players persists even when a reversal or reduction is possible.[3]

The intuition behind this result is that reducible and reversible advantages influence the effort players exert in the second period, depending on who wins in the first period. If A wins, then the second-period contest remains asymmetric. As a result, B expends less due to lower marginal productivity of expenditure, and A also spends less as the best response. However, when B wins, the advantage of A declines or reverses. In this case, A's and B's effectiveness of effort become more similar, and the contest becomes more symmetric, which induces a higher effort from both players. Hence, in addition to the incentive that emerges from preserving advantage (similar to B's incentive of overcoming disadvantage), A also has the incentive to protect asymmetry to reach the low effort-inducing equilibrium in the second period, which happens when A wins and B loses.

I test the theoretical predictions of the model using data from a laboratory experiment. Subjects make bidding decisions (a proxy for effort choices) to influence their likelihood of winning in repeated contests. Types A (advantaged) and B (disadvantaged) are randomly assigned, and then subjects are randomly and anonymously matched into pairs of A and B. Each unit of A's bid is multiplied by three, while B's bid is not multiplied to determine their likelihood of winning. A's multiplier remains the same under the fixed advantage treatment, reduces to one if B initially wins under the reducible advantage treatment, and reverses such that B gets a multiplier of two if B initially wins under the reversible advantage treatment. I also vary A's time preference by changing the weight of their second-period payoff under the fixed and reducible advantage cases.

The experimental data confirm that both players choose higher effort bids when the initial advantage can decline or reverse than when it is fixed. However, the increase in effort bids is significantly higher for the advantaged player when both players have equal (time) preference for the second period under reversible advantage and higher but not significantly under reducible advantage. The disadvantaged players

[2]Global evidence on systematic differences in time preferences exists (Falk et al., 2018), yet this threshold is strict and potentially unrealistic in most contexts. For example, a disadvantaged player may be more concerned about their future welfare than an advantaged player, yet the difference is unlikely to be as large as the theoretical requirement.

[3]Alternative specifications and modeling choices such as additive advantages, a difference in A and B's prizes of winning, or the marginal costs of effort and convex costs generate similar qualitative predictions as discussed in appendix B.

have a significantly lower frequency of winning when they can overcome the initial disadvantage by winning. As a result, there is a small chance that disadvantages are overcome even under the flexible cases (both reducible and reversible). The result flips for the special case when A's total payoff has a sufficiently lower weight on the second-period payoff than B's.

The empirical findings also suggest that social preferences such as inequity aversion do not play an important role in influencing people's behavior in such competitive settings. The advantaged subjects do not aid the process of reducing inequality; instead resist it to keep their advantage. Moreover, disadvantaged subjects do not try to overcome the disadvantage harder than to gain an advantage (reducible versus reversible cases).

This paper contributes to our understanding of the dynamic process of moving from inequality to equality in competitive settings, focusing on the competitors' reactions. Prior research has examined how competitors respond to advantages and disadvantages in static environments or dynamic contests characterized by fixed disadvantages but has not explored their responses to flexible disadvantages (see (Hillman and Riley, 1989; Gradstein, 1995; Corchón, 2000; Cornes and Hartley, 2005) for studies on static contests with disadvantages, and (Cairns, 1989; Leininger and Yang, 1994; McBride and Skaperdas, 2006; Wirl, 1994; Garfinkel and Skaperdas, 2000; Skaperdas and Syropoulos, 1996) for dynamic contests with fixed disadvantages, as well as (Konrad, 2009; Dechenaux et al., 2015; Chowdhury et al., 2023) for comprehensive surveys on contest theory and experiments). I build on this research by examining competitors' behavior in scenarios with flexible disadvantages such as their track record of success in comparison to fixed disadvantages such as institutional or legal barriers. Understanding these dynamics is pivotal for unraveling why disadvantages often persist and determining whether policy interventions remain necessary, even when change is possible.

The paper also contributes to the large literature on asymmetric contests and optimal contest design. The existing literature has primarily shown that because asymmetry reduces expenditure in contests, the optimal contest design to maximize total expenditure or efforts of the players involves making contests as symmetric as possible by compensating for asymmetries in players' cost, valuation, the productivity of effort, endowments (Brown, 2011; Che and Gale, 2003; Epstein et al., 2011; Franke et al., 2018, 2013; Kirkegaard, 2012; Nti, 2004). Moreover, some studies show that the incentive to reveal information about players' strengths depends on whether it creates higher or lower beliefs about symmetry between players (Denter et al., 2022; Fu and Wu, 2022; Kubitz, 2023).

However, when contestants have to compete repeatedly, I show that when a contest is biased in favor of one player, then creating the threat of losing advantage and the opportunity of overcoming disadvantage by winning can generate even higher effort from both players than in a symmetric contest. For instance, if a manager of an internship program wants to incentivize interns' efforts, it may be optimal to let them compete with the possibility of overcoming their initial disadvantages by winning. The total effort would be even higher when interns compete for prizes and advantages. The manager might treat some interns more favorably than others and create competition for manager's favoritism in addition to interns' competitive bonus inducing higher efforts, showing that discrimination in dynamic competitive settings may be a strategic choice rather than due to generally believed non-strategic taste or belief-based reasons (Fang and Moro, 2010).

While the framework I discuss applies to many contexts involving repeated contests between players of asymmetric strengths, it particularly contributes to our understanding of the economics of discrimination. Relating with the conventional taste-based and statistical models of discrimination (Becker, 1957; Phelps, 1972; Aigner and Cain, 1977), I highlight the inadequacy of simply relying on evidence that belief-based discrimination against disadvantaged communities declines after their initial success (Beaman et al., 2009; Bohren et al., 2019; Fryer Jr, 2007; Groot and Van Den Brink, 1996; Lewis, 1986; Mengel et al., 2019). While most of this literature is focused on the source of discrimination and the behavior of the discriminator, I abstract away from it and focus on the behavior of competitors who make economic choices in such environments. I argue that the possibility of overcoming discrimination may not necessarily materialize in equilibrium, suggesting that external policy interventions may be needed to mute competition between unequal players (Fang et al., 2020) or address the initial disadvantage unconditionally.[4]

Furthermore, the competition for advantages described in this paper is closely related to the stratification economics approach to understanding inequality due to Darity (2005) and reviewed in Darity (2022).[5] My approach is similar in that the starting point is the existence of disparity, and the persistence of disparity is not due to an innate characteristic of disadvantaged people. However, I differ in that the stratification economics literature explains the persistence of inequality through the cultural transmission of advantages among the advantaged, which is a relatively passive process. In contrast, I show that advantaged individuals actively choose to

[4]Such unconditional changes are relatively difficult but indeed possible. For example, Boisjoly et al. (2006) shows that white students randomly assigned to black roommates in college have greater empathy and lower racist attitudes. Recently, Dhar et al. (2022) found that childhood intervention discussing gender roles and stereotypes reduces sexist attitudes among students and their families.

[5]I reinterpret players A and B as groups A and B, and β as in-group welfare concern parameter.

expend resources to preserve their advantage due to the incentives that emerge from the competition and the behavioral response to becoming disadvantaged from advantaged.

The rest of the paper is structured as follows. Section I presents the model of reducible and reversible disadvantages while allowing for heterogeneity in future concerns among the advantaged and disadvantaged competitors and gathers the main theoretical results. Section II describes the experimental design to test the theoretical predictions. Section III presents empirical findings based on the laboratory experiment. Section IV concludes with a summary of results and a discussion of implications.

1 Theoretical Model and Predictions

Next, I describe a repeated contest game between two players, one advantaged and one disadvantaged. This framework allows for a comparison of contests in which the outcome of the first contest determines whether the relative advantage remains unchanged, declines or reverses in the second period.

Players: Two players, indexed by $i \in \{A, B\}$, compete in a repeated contest over two periods, $t \in \{1, 2\}$. In each period, players compete for a uniform prize of fixed value V, such that $V_1^i = V_2^i = V$ for all $i \in \{A, B\}$.

Each player i makes an expenditure of e_t^i in period t to influence their probability of winning, denoted as p_t^i. e_t^i can be interpreted as either resource expenditure or exertion of effort by player i in period t.

The utility of player i in period t is given by:

$$U_t^i = p_t^i V - e_t^i, \quad \text{for } i \in \{A, B\}. \tag{1}$$

For ease of exposition, I assume that the marginal cost of effort is constant and normalized to one. Each player maximizes their total expected utility over the two periods. The aggregate utility function is:

$$U^i = U_1^i + \beta^i U_2^i, \tag{2}$$

where $\beta^i \geq 0$ represents player i's time preference for future payoffs. Importantly, I allow for heterogeneity in time preferences, such that $\beta^A \neq \beta^B$, reflecting empirical evidence of systematic differences in discount factors based on identity characteristics such as gender, nationality, and age (Falk et al., 2018). Moreover, I allow for the possibility that $\beta^i > 1$, which captures scenarios where period 2 represents an aggregated future that may be perceived as more valuable than the present.

Players have heterogeneous productivities of effort, denoted by $\alpha_t^i \geq 1$ for each player $i \in \{A, B\}$ in each period $t \in \{1, 2\}$. The contest success function (CSF) maps the effort levels of the players and their respective productivities of effort into their probability of winning in each period t, denoted p_t^i for $i, j \in \{A, B\}$ with $i \neq j$.

Without loss of generality, I assume that $\alpha_1^A > \alpha_1^B$, meaning player A starts with a higher productivity of effort and is initially advantaged. I define the advantage ratio as

$$f_t \equiv \frac{\alpha_t^A}{\alpha_t^B}, \tag{3}$$

which measures how much more productive player A's effort is compared to player B's effort in period t. If both players exert the same effort in period t, then player A's probability of winning exceeds player B's by a factor of f_t. Since $\alpha_t^i \geq 1$ for all $i \in \{A, B\}$, it follows that $f_t > 0$ for each period $t \in \{1, 2\}$.

To model competition between players with asymmetric productivities of effort, I adopt the Tullock lottery contest success function. The probability of winning for each player in period t is given by:

$$(p_t^A, p_t^B) = \begin{cases} \left(\dfrac{f_t e_t^A}{f_t e_t^A + e_t^B}, \dfrac{e_t^B}{f_t e_t^A + e_t^B} \right) & \text{if } \max\{e_t^A, e_t^B\} > 0, \\ \left(\dfrac{f_t}{f_t + 1}, \dfrac{1}{f_t + 1} \right) & \text{if } e_t^A = e_t^B = 0. \end{cases} \tag{4}$$

Change in Advantage: Depending on the source of the disadvantage, player B may or may not overcome it by winning. Consider three cases. Case 1 (fixed advantage) concerns situations where the source of advantage and disadvantage is fixed, such as ability. In this case, the advantage ratio remains constant across periods regardless of who wins, i.e.,

$$f_2 = f_1. \tag{5}$$

Case 2 (reducible advantage) concerns situations where the disadvantage stems from a factor that winning can mitigate, such as belief-based discrimination, player B's disadvantage decreases upon winning. In this case,

$$f_2 \in [1, f_1) \quad \text{if B wins,} \quad \text{and} \quad f_2 = f_1 \quad \text{if A wins.} \tag{6}$$

Finally, case 3 (reversible advantage) concerns situations where advantages and disadvantages arise from a contest-dependent factor, such as incumbency, winning can not only eliminate but also reverse the initial disadvantage. Under this scenario,

$$f_2 \in (0, 1) \quad \text{if B wins,} \quad \text{and} \quad f_2 = f_1 \quad \text{if A wins.} \tag{7}$$

Equilibrium: Players A and B choose effort levels to maximize their expected utilities in each period. Since the outcome of period 1 influences the level of advantage in period 2, I solve the game using backward induction to derive the subgame perfect Nash equilibrium.

In period 2, the game concludes, and players engage in a one-shot contest, yielding the following equilibrium outcomes for effort, winning probabilities, and utilities:

Equilibrium efforts:

$$e_2^A = e_2^B = \frac{f_2}{(f_2+1)^2}V. \tag{8}$$

Equilibrium probabilities of winning:

$$p_2^A = \frac{f_2}{f_2+1}, \quad p_2^B = \frac{1}{f_2+1}. \tag{9}$$

Equilibrium utilities:

$$U_2^A = \frac{f_2^2}{(f_2+1)^2}V, \quad U_2^B = \frac{1}{(f_2+1)^2}V. \tag{10}$$

Equation (2) leads to the following lemma, which aligns with a well-established result in the contest literature (Chowdhury et al., 2023).

Lemma 1. *In the second period, the initially advantaged player (A) and the initially disadvantaged player (B) exert equal efforts, decreasing in f_2 when $f_2 > 1$ and increasing in f_2 when $f_2 < 1$.*

The second period, being the final period resembles a one-shot contest. Effort is maximum when the contest is symmetric i.e., at $f_2 = 1$ and decreases as $f_2 = 1$ moves farther away from 1.

In the first period, players consider the impact of the first-period outcome on the second-period advantage and maximize their expected utilities given by,

$$U_1^A(e_1^A, e_1^B) = \frac{f_1 e_1^A}{f_1 e_1^A + e_1^B}V_A - e_1^A \tag{11}$$

$$U_1^B(e_1^A, e_1^B) = \frac{e_1^B}{f_1 e_1^A + e_1^B}V_B - e_1^B, \tag{12}$$

The prize of winning the contest in period one is V for each player. However, the possibility of preserving advantage and overcoming disadvantage creates additional future benefits from winning for the players, reflected in V_A and V_B. V_i represents the difference in the ex-ante expected utility of player i if they win in period 1 compared to

if they lose in period 1, where $i \in \{A, B\}$. When players have positive time preferences for future (β^A and β^B), they choose their first-period efforts to maximize their expected utility from the current prize and the future benefits from winning. Solving the best response functions based on equations (11) and (12), generates the following equilibrium outcome in period 1:
Equilibrium efforts:

$$e_1^A = \frac{f_1 V_A^2 V_B}{(f_1 V_A + V_B)^2}, \qquad e_1^B = \frac{f_1 V_B^2 V_A}{(f_1 V_A + V_B)^2} \tag{13}$$

Equilibrium probabilities of winning:

$$p_1^A = \frac{f_1 V_A}{f_1 V_A + V_B}, \qquad p_2^B = \frac{V_B}{f_1 V_A + V_B} \tag{14}$$

Equilibrium expected utilities:

$$U_1^A = \frac{f_1 V_A}{f_1 V_A + V_B}\left[V - \frac{f_1 V_A V_B}{f_1 V_A + V_B}\right], \quad U_1^B = \frac{V_B}{f_1 V_A + V_B}\left[V - \frac{f_1 V_A V_B}{f_1 V_A + V_B}\right] \tag{15}$$

where,

$$V_A = \left[1 + \beta^A\left(\frac{f_1^2}{(f_1+1)^2} - \frac{(f_2)^2}{(f_2+1)^2}\right)\right]V, \quad V_B = \left[1 + \beta^B\left(\frac{1}{(f_2+1)^2} - \frac{1}{(f_1+1)^2}\right)\right]V \tag{16}$$

In the case of fixed disadvantage, $f_2 = f_1$ regardless of who wins. The outcome of period 1 has no effect on the expected future utility of period 2 for either player. Therefore, $V_A = V_B = V$ under a fixed disadvantage, and the first-period efforts are chosen similar to the second period or a one-shot contest, i.e., $e_1^A = e_1^B = \frac{f_1}{(f_1+1)^2}V$ in this case.

However, in the cases of reducible or reversible advantage, the incentive to preserve the advantage and reduce or reverse the disadvantage causes $V_i > V \forall i \in \{A, B\}$. In addition to the exogenously given per-period prize V and time preference parameters β^i, the value from winning in the first period is composed of two main components.

First, consider the difference in advantage or probability of winning for each player, given equal efforts, if they win versus if they lose. For player A, this difference is calculated using $\frac{f_1}{f_1+1} - \frac{f_2}{f_2+1}$, and for player B, it is calculated using $\frac{1}{f_2+1} - \frac{1}{f_1+1}$. This difference is the same for both players. Given equal efforts, both players have a higher chance of winning in the second period if they win in the first period. This creates an additional incentive for both of them to put in more effort and win in the first period. However, this incentive is the same for both players and results in an equal increase in their effort choices.

Secondly, the levels of effort that each player exerts in equilibrium in the second period will depend on who wins in the first period. If B wins in the first period, the advantage will decrease or reverse in the second-period contest. As a result, the contest will become more symmetric because the players' productivities of effort will become more similar to each other. Lemma 1 tells us that if B wins in the first period, each player will need to exert a high level of effort in the second-period contest, which will be relatively symmetric. On the other hand, if A wins in the first period, the second-period contest will be asymmetric and require less effort from each player in equilibrium. Therefore, A has an additional incentive to increase effort to win in the first period in order to preserve the asymmetry, an incentive that B lacks. High effort-inducing symmetry crowds out some of the benefit for B from overcoming the disadvantage.

Taking the probability-increasing first component and the effort-inducing second component together, we know that both players A and B exert a higher effort under reducible and reversible advantage, i.e., $V_i > V \; \forall i \in \{A, B\}$. But, the increase is greater for the advantaged player A than the disadvantaged player B due to A's incentive to preserve the low effort inducing asymmetry, i.e., $V_A > V_B \implies e_1^A > e_1^B$ and P_1^B(reducible advantage) $<$ P_1^B(reversible advantage) $<$ P_1^B(fixed advantage). The only condition under which this result will not hold is when A's time preference for the future is sufficiently lower than B, such that A is not sufficiently incentivized to preserve advantage or asymmetry. In this case, B's total incentive to overcome the initial disadvantage is higher than A's incentive to preserve their advantage, or $V_A < V_B$ and $e_1^A > e_1^B$ enabling B to benefit from reducible and reversible disadvantages: P_1^B(reversible advantage) $>$ P_1^B(reducible advantage) $>$ P_1^B(fixed advantage). Comparing V_A and V_B determines the necessary threshold for A and B's time preference as a function of the initial advantage f_1 and subsequent advantage f_2 denoted by γ, which is smaller than one. These theoretical predictions are presented in Proposition 1.

Proposition 1. *Assuming positive time preference for the future for A and B denoted by β^A and β^B, respectively, a first-period advantage towards A of $f_1 > 1$, and a second-period advantage towards A of f_2, where $f_2 = f_1$ if A wins in the first period, $f_2 \in [1, f_1)$ if B wins in the first period and the advantage is reducible, and $f_2 \in (f_1, f_1^{-1})$ if B wins in the first period and the advantage is reversible, then the equilibrium efforts in period 1 are characterized by the following:*

a) Both players exert higher equilibrium efforts under reducible and reversible advantages compared to fixed advantage.

b) Both players exert equal equilibrium efforts under fixed advantage.

c) Unless A's time preference for the future is sufficiently lower than B's, the equilibrium effort of the advantaged player A is higher than that of the disadvantaged player B under reducible and reversible advantages. Specifically, if $\beta^A > \gamma\beta^B$*, then* $e_1^A > e_1^B$*, and if* $\beta^A < \gamma\beta^B$*, then* $e_1^A < e_1^B$*, where* $\gamma = \dfrac{(2 + f_2 + f_1)}{f_1 + f_2 + 2f_1^2} < 1$.

The proof of this and the following proposition is in Appendix A. The players' equilibrium probability of winning is only determined by the initial advantage parameter f_1 under fixed advantage. Since both players exert equal efforts under fixed advantage, A and B's probabilities of winning are given by $\dfrac{f_1}{f_1+1}$ and $\dfrac{1}{f_1+1}$, respectively (see equation 1). However, when the advantage is reducible or reversible, A is incentivized to exert a higher effort than B, further reducing B's probability of winning in the first period. This effect increases the initial asymmetry and the subsequent symmetry that would be generated by B winning. As a result, the probability that B wins in the first period and overcomes the initial disadvantage is characterized as follows.

Proposition 2. *B's probability of winning in the first period and overcoming the initial disadvantage* P_1^B *is decreasing in* $\dfrac{f_1}{f_2}$ *if* $\beta^A > \gamma\beta^B$*, U-shaped in* $\dfrac{f_1}{f_2}$ *if* $\beta^A \in (\gamma\beta^B, \beta^B)$ *and increasing in* $\dfrac{f_1}{f_2}$ *if* $\beta^A < \gamma\beta^B$*, where* $\gamma = \dfrac{(2 + f_2 + f_1)}{f_1 + f_2 + 2f_1^2} < 1$.

The findings that both players invest more when advantages are flexible than fixed, and that the increase in A's effort is generally higher than the increase in B's effort are mainly driven by the negative relation between asymmetry in contests and contest effort or investment. Thus, the qualitative results are robust to other specifications and alternative models, which I discuss in appendix B.

The next section presents the experimental design to test the theoretical predictions of the model.

2 Experimental Design and Procedure

The experiment is designed to study the impact of reducible advantage when both players care about period two equally and when the advantaged type A cares sufficiently less about period-two than the disadvantaged type B (i.e., $\beta^A < \gamma\beta^B$). The impact of reversible advantage under the equal time preferences condition is also tested. I use the between-subjects design for the five treatments (summarized in table 1). The initial advantage towards A (f_1) is 3 in each treatment, i.e., all else equal, A is thrice as likely to win as B. Period-two advantage towards A if A had won in period one remains 3 in each treatment. Period-two advantage towards A, if B had won in period one (f_2), remains 3 under fixed advantage, becomes one under reducible advantage, and becomes 0.5 under reversible advantage. B's time preference for the future (β^B) is 5. A's time preference for the future (β^A) is 0.1 when A cares sufficiently lesser about the future than B, five otherwise[6]. The endowment and the payoff from winning are 100 points for both types in each period.

Table 1: Treatment table

	$(f_1, f_2$ if B wins in period 1, $\beta_a, \beta_b)$		
	Fixed advantage	**Reducible advantage**	**Reversible advantage**
Equal Beta ($\beta_A = \beta_B = 5$)	(3, 3, 5, 5)	(3, 1, 5, 5)	(3, 0.5, 5, 5)
Unequal Beta ($\beta_A = 0.1, \beta_B = 5$)	(3, 3, 0.1, 5)	(3, 1, 0.1, 5)	-

Note that the case with $\beta^A \geq \gamma\beta^B$ is specified using equal time preferences, i.e., $\beta^A = \beta^B$ as $\gamma < 1$. The choice of equal βs for this case has an intuitive appeal for contexts where we do not have a reason to believe that the advantaged and the disadvantaged types will differ in their time preference. I choose the parameter values of V and f to contextualize the data with the existing literature. The choice of βs ensures a clear difference in predicted efforts under different treatments. A higher than one value of β is interpreted as the reduced form valuation of a stream of future periods aggregated in period 2. The choice of f_2 is intuitively appealing and easy to apply in the lab as it means that the disadvantage is reinforced in the second period when A wins in the first period and completely goes away when B wins in the first period.

The theoretical predictions of the bids in period 1 of the advantaged and the disadvantaged types (e_1^A, e_1^B) are given in table 2. Both types are expected to bid higher under reducible and reversible advantaged than a fixed advantage. The increase in bids due to reducible advantage is higher for type A than type B if relative $\beta = 1$ and lower if relative $\beta = 0.02$.

Table 2: Theoretical Predictions of Bids in Period 1

	Bids - (e_{1a}, e_{1b})		
	Fixed advantage	**Reducible advantage**	**Reversible advantage**
Equal Beta ($\beta_A = \beta_B = 5$)	18.75, 18.75	41,31	58,51
Unequal Beta ($\beta_A = 0.1, \beta_B = 5$)	18.75, 18.75	24.4, 45.8	-

There are three key hypotheses regarding the players' bids in the first period:

Hypothesis 1 (Reducible). When $\beta^A = \beta^B$, each type bids higher under reducible disadvantage than fixed advantage, but the increase is greater for the advantaged type.

[6]The treatment table is given in Appendix B.

Hypothesis 2 (Reversible). When $\beta^A = \beta^B$, each type bids higher under reversible disadvantage than fixed advantage, but the increase is greater for the advantaged type.

Hypothesis 3 (Time Preferences). When $\beta^A = 0.02\beta^B$, each type bids higher under reducible disadvantage than fixed advantage, but the increase is greater for the disadvantaged type.

The experiment has four parts followed by puzzles and a demographic survey. Part 1 measures the players' baseline behavior in contests and consists of 5 rounds of fair or non-discriminatory symmetric contests where each round consists of two periods. Part 2 induces and measures attentiveness with the incentivized slider task of setting a maximum number of sliders to given numbers between 0 and 100 in a minute (Gill and Prowse, 2012). Part 3 is the primary treatment task and comprises 10 rounds of the contest with (dis)advantage, where each round consists of two periods. Part 4 is one round of a single period of a non-discriminatory contest for a prize worth 0 to measure subjects' innate preference for winning regardless of the prize. The sessions end with puzzles such as the cognitive test, (Holt and Laury, 2002) risk preference lottery task, the Hanoi task to measure farsightedness, and a demographic survey. All the parts are explained in detail below.

I programmed the experiment with the software oTree (Chen et al., 2016) and executed it online with undergraduate students at the University of California Irvine. 308 subjects participated in the study, with about 62 per treatment. Each individual participated in only one session, and no subject knew anything about this project or had any experience participating in a similar experiment. I added several quizzes to ensure alertness and comprehension of instructions. Following is the procedure followed in parts 1 and 3. Subjects are randomly assigned to different treatments and roles (A or B) and randomly and anonymously matched into pairs of A and B. They play two periods of a contest in each round. There is an endowment of 100 points and a winning prize of 100 points in each period. They choose how much they want to bid out of 100 to influence their probability of winning and keep the rest.

I explain player A's advantage and player B's disadvantage in the productivity of bids using neutral language as follows. Subjects are informed that A's bid is multiplied by three, while B's bid is multiplied by one to determine the number of A and B type balls put into the bid bag. A ball is then randomly drawn from the bid bag to determine the winner. If B wins in period 1, A's bid is multiplied by one (or two) in period 2 of the reducible (or reversible) advantage treatment.

Players are not explicitly informed what happens if both make zero bids, but the decision screen has sliders for own and matched player's bids to calculate the corresponding probabilities of winning. When the sliders are set to zero for both players, it returns a 50 percent probability of winning. While there may be a behavioral impact if the scenario of both choosing zero bids is made salient and brought attention to, this is not an equilibrium outcome under any treatment and is unlikely to occur. In fact, there are no interactions where both players chose zero bids, or where one player chose zero and perceived their opponent to do the same. Additionally, I find no significant difference in the likelihood of choosing zero bids by treatment or player type.

A and B's time preferences are invoked in the following way. In the case of equal time preferences, the total payoff for each type is the payoff in period 1 plus 5 times the payoff in period 2. In the case of unequal time preferences, the total payoff for type A is the payoff in period 1 plus 10 percent of the payoff in period 2, while the total payoff for type B is the payoff in period 1 plus 5 times the payoff in period 2. The parameters are chosen to ensure a large enough difference in the point prediction of bids under different treatments. Each session consists of 10 rounds of the repeated asymmetric contest. Subjects are anonymously and randomly re-matched with someone else of the opposite type in each round. One round is then picked at random for actual payment (1 = 100 points). Every subject engages in 5 rounds of repeated symmetric contests and a simple effort task to measure attentiveness before the central part of the 10 rounds of the repeated asymmetric contest.

The decision screen provides information about the subject's type, the value of the prize and own, and other type's balls per point of the bid. It also has sliders and corresponding input box fields for subjects to submit the prediction of their match's bid and their bid. The subjects choose to type the bids or move the slider (both are synchronized). The decision screen has a calculator for subjects to find their expected payoff. They can move the sliders to try as many bid combinations as they want in each period. It also has a reminder box for subjects' type and relevant β.

At the end of each round, a results screen informed subjects whether they had won or not, their bid, match's bid, prediction, prediction payoff, task payoff, and total payoff in that round. I used the random lottery payment mechanism to ensure that the subjects treat every round as a separate task and that the stakes are not distributed over rounds. Even though this relies on the assumption that subjects are expected utility maximizers, which also affects the central question of interest in this paper, (Hey and Lee, 2005) show that under random lottery payment mechanism, subjects do answer as if they were separating the tasks over rounds.

The next part was also a bidding task with only one round of 1 period to measure subjects' preference for winning following (Sheremeta, 2010). Subjects are given an endowment of 50 points. They could choose how much to bid for a prize of 0 points. There were no types, i.e., it was a symmetric one-shot contest. This part was to measure subjects' preference for winning for its own sake as they have to incur costs for no prize. Experiments in contests often find overbidding relative to the Nash predictions. Preference for winning is an important reason for overbidding.

In the end, subjects filled in a survey consisting of a demographic questionnaire, cognitive reflection test to measure ability, incentivized tower of Hanoi task to measure the inclination and ability to do backward induction, and a modified (Holt and Laury, 2002) lottery task to measure risk preference. Payments consisted of the accumulated earnings throughout the experiment. Each session lasted about 60 minutes, and the subjects' average payment was 20 USD. Screenshots of all the pages in the case of reducible advantage with relative time preference = 0.02 are provided in appendix C.

3 Empirical Findings

In Section 3.1, I analyze how reducible and reversible advantages affect effort bids, winning frequencies, and payoffs when players A and B have equal time preferences. In Section 3.2, I examine how reducible advantages impact bidding behavior under unequal time preferences.

To study the effect of reducible and reversible advantages on period 1 bids, I estimate the following panel regression model separately for equal and unequal time preference cases:

$$\text{Bid1}_{it} = \beta_0 + \beta_1 \text{Treatment}_{it} + \beta_2 \text{Favored}_i + \beta_3 (\text{Favored}_i \times \text{Treatment}_{it}) + \gamma X_{it} + \delta t + \varepsilon_{it} \quad (17)$$

where Bid1_{it} is the bid of player i in round t, Treatment_{it} is an indicator for whether the advantage is reducible or reversible, Favored_i denotes whether the player starts with an advantage, and their interaction term captures differential effects of reducibility or reversibility for advantaged and disadvantaged players. The vector X_{it} includes control variables such as the average bid in symmetric contests, the predicted bid of the opponent, innate preference for winning, age, farsightedness, and risk aversion and controlling for round fixed effects (which also controls for learning over rounds). I employ panel regression analysis, clustering standard errors at the player level to account for within-player correlation across rounds.

For robustness, I report results from OLS regressions where the dependent variable is a player's average first-period bid over 10 rounds in Appendix C. These results are qualitatively similar to the main panel regression findings.

3.1 Equal Time Preferences

For this section, I focus on cases where both advantaged and disadvantaged players have equal time preferences.

Table 3: **Effect of reducible advantage on period 1 bids (Equal time preferences)**

	Advantaged	Disadvantaged	Advantaged and Disadvantaged
Reducible Advantage	14.509***	6.444*	5.803
	(3.803)	(4.987)	(4.797)
Advantaged			-4.645
			(4.202)
Advantaged × Reducible			10.140**
			(6.140)
Mean [under fixed advantage]	36.45	39.52	
Controls	Yes	Yes	Yes
No. of Observations	880	880	1760

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 3 presents the effect of reducible advantage on period 1 bids under equal time preferences. Columns (1) and (2) show that both advantaged and disadvantaged players bid higher when the advantage is reducible, but the increase is statistically significant only for advantaged players. Column (3) includes an interaction term between being advantaged and having a reducible advantage. The positive and significant coefficient confirms the hypothesis that the increase in bidding due to reducible advantage is significantly larger for advantaged than the disadvantaged players. The coefficient on the "Advantaged" variable in column (3) indicates that under fixed advantages, advantaged and disadvantaged players bid at similar levels, as expected. These findings suggest that when an advantage is reducible, advantaged players increase their bidding significantly, bidding higher than the disadvantaged players. In column (1) of table 8, I show that the higher bids significantly improve the advantaged players' winning chances (7pp) under reducible advantage relative to fixed. However, ultimately it leads to lower payoffs for both players as they bid higher and increase their costs, as shown in appendix table 9.

Finding 1 (Reducible). When $\beta^A = \beta^B$, advantaged type bids significantly higher under reducible advantage than fixed advantage, while the disadvantaged type's increase in bid due to reducible advantage is smaller and not significant.

Next, I present the results examining the effect of reversible advantage. Recall that the initially disadvantaged type B becomes advantaged in the second period if and only if they had won in the first period. There is a smaller change in asymmetry under reversible advantage than reducible disadvantage, thereby increasing the importance of the threat of loss and the opportunity to gain favorable advantage in determining probabilities of winning compared with the future costs associated with them. Columns (1) and (2) of table 4 show that only the advantaged player responds to the possibility of reversible advantage, increasing their bids by a large and significant margin.

Table 4: **Effect of reversible advantage on period 1 bids (Equal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reversible Advantage	17.263***	3.568	-0.681
	(4.542)	(7.416)	(7.178)
Advantaged			-4.575
			(4.259)
Advantaged × Reversible			19.313**
			(8.588)
Mean [under fixed advantage]	36.45	39.52	
Controls	Yes	Yes	Yes
No. of Observations	700	700	1400

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Consequently, Column (3) of table 4 confirms that the interaction effect between being advantaged and reversible advantage is positive and significant. Column (2) of Table 4 further shows that the disadvantaged player is significantly less likely to win the first period contest when advantage is reversible rather than fixed (13 pp). This is interesting because it implies that the contexts where advantages reverse after initial success of the disadvantaged (such as discrimination (Bohren et al., 2019; Beaman et al., 2009)) are even more likely to see a persistence of disadvantages, with a lower payoff for both types (appendix table 10).

Finding 2 (Reversible). When $\beta^A = \beta^B$, only the advantaged type bids significantly higher under reversible advantage than fixed advantage, while the disadvantaged type's bid remains unchanged.

Empirical findings from the experiment broadly support the theoretically informed hypotheses, particularly regarding the advantaged player. Reducible and reversible advantages lower the disadvantaged type's initial chances of winning. However, this effect is primarily driven by higher bids from advantaged players seeking to maintain their advantage. In contrast, disadvantaged players do not significantly adjust their bids, even when given the opportunity to overcome or reverse their disadvantage. This lack of response is somewhat puzzling. While theory predicts a smaller treatment effect for disadvantaged players compared to advantaged players under equal time preferences, the data show almost no systematic effect on disadvantaged players.

One possible explanation is that reducible and reversible advantages trigger loss aversion among advantaged players (Kahneman et al., 1991). The prospect of losing their advantage may outweigh the opportunity for disadvantaged players to overcome it, especially in the reversible treatment, where the potential loss is even greater. If disadvantaged players anticipate this intensified competition, they may perceive their probability of winning as lower, further discouraging them from increasing their bids. While not directly testable, the loss aversion mechanism is consistent with my findings: comparing Table 5 with Table 3 and Table 6 with Table 4 reveals minimal differences between predicted and actual bidding behavior. Thus, loss aversion may further limit the effectiveness of reducible and reversible disadvantages in mitigating disparities in dynamic competitive settings.

Table 5: **Effect of reducible advantage on period 1 predicted bids of the matched participants (Equal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reducible Advantage	14.071***	16.291***	16.264***
	(4.098)	(2.704)	(2.698)
Advantaged			5.980**
			(3.544)
Advantaged × Reducible			-2.250
			(4.858)
Mean [under fixed advantage]	39.56	33.19	
Controls	Yes	Yes	Yes
No. of Observations	880	880	1760

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 6: **Effect of reversible advantage on period 1 predicted bids of the matched participants (Equal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reversible Advantage	7.513*	19.089***	18.257***
	(5.031)	(3.433)	(3.685)
Advantaged			6.300**
			(3.602)
Advantaged × Reversible			-9.841*
			(6.240)
Mean [under fixed advantage]	33.19	39.56	
Controls	Yes	Yes	Yes
No. of Observations	700	700	1400

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, foresightedness, attention and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

3.2 Unequal time preferences

Next, I analyze how a reducible advantage affects bidding behavior under unequal time preferences. Table 7 presents the results. Columns (1) and (2) show that, unlike the equal time preferences case, both advantaged and disadvantaged players bid significantly higher when the advantage is reducible. The advantaged players increase their bid in response to reducible advantage despite an almost negligible weight on the second period, which further illustrates the strong effect of threat of losing advantage.

Table 7: **Effect of reducible advantage on period 1 bids (Unequal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reducible Advantage	12.090***	25.274***	24.459***
	(4.181)	(6.695)	(6.610)
Advantaged			8.328*
			(5.153)
Advantaged × Reducible			-13.882**
			(7.938)
Mean [under fixed advantage]	27.79	21.40	
Controls	Yes	Yes	Yes
No. of Observations	600	600	1200

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Column (3) introduces an interaction term between being advantaged and having a reducible advantage. The negative and significant coefficient indicates that the increase in bids for disadvantaged players is significantly larger than for advantaged players, reversing the pattern observed under equal time preferences, as predicted. The coefficient on the *Advantaged* variable shows that under fixed advantages, advantaged players bid slightly higher than disadvantaged players, but the difference is modest. As seen in column (3) Table 8, the higher bidding by disadvantaged players also translates into significantly more wins (9pp), but the costs of higher bidding also reduce their overall payoffs, as shown in Appendix Table 11.

Finding 3 (Unequal Beta). When $\beta^A = 0.02\beta^B$, both types bid significantly higher under reducible advantage than fixed advantage, but the increase is greater for the disadvantaged type.

Table 8: **Effect of reducible and reversible advantages on period 1 winning frequencies of the inititally disadvantaged player B**

	Equal Beta	Equal Beta	Unequal Beta
Reducible Advantage	-0.065*		0.089**
	(0.043)		(0.053)
Reversible Advantage		-0.117**	
		(0.053)	
Mean [under fixed advantage]	0.31	0.31	0.20
Controls	Yes	Yes	Yes
No. of Observations	880	700	600

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

4 Conclusion

This paper identifies and discusses one reason why disadvantages persist even when there is an opportunity for change. I use a combination of theoretical and experimental methods to examine the effect of flexible advantage on people's economic outcomes. Organizations often rely on competition between agents for resource allocation, such as elections, college admission tests, job interviews, litigation, and sports. Thus, I model the problem in the framework of contest theory (Tullock, 1967). The theoretical analysis predicts that unless the advantaged competitor cares sufficiently lesser about the future than the disadvantaged competitor, the possibility of a decline or reversal in advantages and disadvantages is unlikely to materialize. I show that the advantaged competitor is even more likely to succeed in a dynamic environment as s/he responds to the threat of losing an advantage.

I present results from a laboratory experiment where subjects are randomly assigned to be the advantaged and disadvantaged players in a repeated contest. I find that the subjects whose advantage declines or reverses if they lose choose significantly higher contest expenditures to win and resist losing their advantage. Similarly, the subjects whose disadvantage declines or reverses if they win choose significantly higher contest expenditures to win and overcome their disadvantage. However, the increase is greater for the advantaged subjects, resulting in an even higher initial success rate for them and small chances of advantage decline and reversal unless the weight attached to the second-period payoff is sufficiently smaller for them. In fact, the possibility of advantage reversal poses an even greater threat than the possibility of advantage reduction, but it doesn't affect the disadvantaged player's behavior differently.

The paper's main message is that people's response to the possibility of change has non-trivial implications for whether such opportunities and possibilities materialize. Enabling disadvantaged people in contexts such as sports, politics, and the labor market to overcome their disadvantages by proving their mettle is unlikely to achieve equality, as the behavior of the advantaged people also matters for the overall outcomes. However, if the policymaker's objective is not equality but incentivizing efforts, then creating such a competition for advantages might be helpful. These dynamics may be an economic rationale for employers' initial favoritism toward some employees. The competition to remain and become the employer's favored employee induces higher efforts from all employees while the initially favored employee maintains this position. However, this remains an empirical question for future work. Overall, this paper argues that the incentive of the advantaged people to maintain privilege in competitive environments explains the slow change in disadvantage despite the opportunity to overcome disadvantage even in dynamic and progressive environments.

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Appendix A Proof of propositions

Using backward induction to solve for the subgame perfect Nash equilibrium of the 2-period contest, Consider the second and last period -
If player A won in the first period, then their advantage f remains the same in the second period. The second-period contest success function is given by :

$$P_2^A, P_2^B = \begin{cases} \dfrac{f_2 e_2^A}{f_2 e_2^A + e_2^B}, \dfrac{e_2^B}{f_2 e_2^A + e_2^B} & \text{if } \max\{e_2^A, e_2^B\} > 0 \\ \\ \dfrac{f_2}{f_2+1}, \dfrac{1}{f_2+1} & \text{if } e_2^A = 0 = e_2^B \end{cases}$$

In the Nash Equilibrium of this contest:
Equilibrium efforts:

$$e_2^A = \frac{f_2}{(f_2+1)^2}V, e_2^B = \frac{f_2}{(f_2+1)^2}V \tag{A.1}$$

Equilibrium probabilities of winning:

$$P_2^A = \frac{f_2}{f_2+1}, P_2^B = \frac{1}{f_2+1} \tag{A.2}$$

Equilibrium expected utilities:

$$U_2^A = \frac{f_2^2}{(f_2+1)^2}V, U_2^B = \frac{1}{(f_2+1)^2}V \tag{A.3}$$

where $f_2 = f_1$ if player A won in the first period or if A's advantage is fixed, and $f_2 \in [1, f_1]$ if player B won in the first period and advantage is reducible, and $f_2 \in (f_1^{-1}, 1)$ if player B won in the first period and advantage is reversible.
From equation (A-1) we know that $e_2^A = e_2^B$ and decreasing in f_2 if $f_2 > 1$ and increasing in f_2 if $f_2 < 1$, which proves Lemma 1.

The first-period contest success function is given by :

$$P_1^A, P_1^B = \begin{cases} \dfrac{f_1 e_1^A}{f_1 e_1^A + e_1^B}, \dfrac{e_1^B}{f_1 e_1^A + e_1^B} & \text{if } \max\{e_1^A, e_1^B\} > 0 \\ \\ \dfrac{f_1}{f_1+1}, \dfrac{1}{f_1+1} & \text{if } e_1^A = 0 = e_1^B \end{cases}$$

Using equation (3) above, players maximize their expected utilities in the first period given by,

$$U_1^A(e_1^A, e_1^B) = \frac{f_1 e_1^A}{f_1 e_1^A + e_1^B} V_A - e_1^A$$

$$U_1^B(e_1^A, e_1^B) = \frac{e_1^B}{f_1 e_1^A + e_1^B} V_B - e_1^B$$

where, V_A and V_B are the values from winning in period 1 for players A and B respectively, derived by taking the difference of their total expected utility if they win in the first period and if they lose in the first period.

$$V_A = \left[1+\beta_a\left(\frac{f_1^2}{(f_1+1)^2} - \frac{f_2^2}{(f_2+1)^2}\right)\right]V \qquad \text{and} \qquad V_B = \left[1+\beta_b\left(\frac{1}{(f_2+1)^2} - \frac{1}{(f_1+1)^2}\right)\right]V$$

This generates the following equilibrium outcome of period 1, Equilibrium efforts:

$$e_1^A = \frac{f_1 V_A^2 V_B}{(f_1 V_A + V_B)^2} \qquad \text{and} \qquad e_1^B = \frac{f_1 V_B^2 V_A}{(f_1 V_A + V_B)^2} \tag{A.4}$$

Equilibrium probabilities of winning:

$$P_1^A = \frac{f_1 V_A}{f_1 V_A + V_B} \qquad \text{and} \qquad P_1^B = \frac{V_B}{f_1 V_A + V_B} \tag{A.5}$$

Equilibrium expected utilities:

$$U_1^A = \frac{f_1 V_A}{f_1 V_A + V_B}\left[V - \frac{f_1 V_A V_B}{f_1 V_A + V_B}\right] \quad \text{and} \quad U_1^B = \frac{V_B}{f_1 V_A + V_B}\left[V - \frac{f_1 V_A V_B}{f_1 V_A + V_B}\right] \tag{A.6}$$

From (5),

$$e_1^A > e_1^B \iff V_A > V_B \iff \frac{\beta^A}{\beta^B} > \frac{(2 + f_2 + f_1)}{f_1 + f_2 + 2f_1^2} = I < 1$$

Define $f_2 = \theta f_1$

Note that, V_A and V_B are decreasing in θ.

Further,

$$\begin{aligned}
\frac{\partial\left(\frac{V_A}{V_B}\right)}{\partial\theta} &= \frac{2f_1(f_1+1)^2(\theta f_1+1) - f_1^2\beta^A(\theta+2f_1+1) + f_1^2\beta^A(1-\theta)}{(f_1+1)^2(\theta f_1+1)^2 + f_1\beta^B(1-\theta)(f_1\theta+f_1+2)} \\
&- \frac{(-f_1\beta_B(\theta f_1+f_1+2) + 2f_1(f_1+1)^2(\theta f_1+1)}{((f_1+1)^2(\theta f_1+1)^2 + f_1\beta^B(1-\theta)(\theta f_1+f_1+2))^2} \\
&- \frac{f_1^2\beta^B(1-\theta))((f_1+1)^2(\theta f_1+1)^2 + f_1^2\beta^A(1-\theta)(\theta+2f_1+1))}{((f_1+1)^2(\theta f_1+1)^2 + f_1\beta^B(1-\theta)(\theta f_1+f_1+2))^2} \qquad \text{(A.7)} \\
&< 0 \quad \text{if} \quad \frac{\beta^A}{\beta^B} > \gamma \\
&\text{U - shaped} \quad \text{if} \quad \frac{\beta^A}{\beta^B} \in (1,\gamma), \text{change of slope at } \theta = \theta^*(f_1) \\
&> 0 \quad \text{if} \quad \frac{\beta^A}{\beta^B} < 1
\end{aligned}$$

where $\theta^*(f_1)$ is increasing in f_1 and is found by setting the above equation equal to 0.

Moreover, p_1^A is increasing in $\frac{V_A}{V_B}$ and P_1^B is decreasing in $\frac{V_A}{V_B}$. Thus, P_1^A is increasing, U-shaped and decreasing in (θ^{-1}).
Similarly, U_1^A and U_2^B are decreasing in (θ^{-1}), decreasing in own β and increasing in other player's β.
This proves Propositions 1 and 2. □

Appendix B Theoretical Robustness Checks

1. *Alternative models of advantage* – I model players' advantage and disadvantage as asymmetry in the effectiveness of their contest effort or expenditure in determining their probabilities of winning. Alternatively, one can imagine asymmetry in players' values from winning the contest such that $V_a > V_b$ in the first period causing initial advantage and disadvantage. If the gap between V_a and V_b reduces or reverses in the second period if and only if B wins in the first period, the problem becomes equivalent to the one described above. Both players' utilities are increasing in their own prizes and falling in the prize of the other player. Thus, unless the initial advantage for A is too high (making B's marginal cost from disadvantage higher than A's marginal benefit from advantage), A's increase in effort to preserve the advantage and likelihood of initial success will be higher. A similar argument holds for the case of asymmetry in players' cost functions.

2. *Convex Cost Function* – If the cost function is convex instead of linear as assumed above, then the higher effort cost from symmetric equilibrium is even more relevant for determining players' initial effort or investment choices. Player A's incentive to avoid a change in advantage is stronger and Player B's incentive to overcome disadvantage is even weaker (than linear costs case) as each unit of additional effort becomes more costly. Ultimately the finding that A is even more likely to win the initial contest when advantage can be lost or reversed holds true for a larger set of time preference parameters β_A and β_B when cost functions are convex rather than linear.

3. *Increase in A's advantage upon winning* – Suppose that A's advantage is exacerbated by initial win, i.e., it increases to a higher level in the second period when A wins in the first period (instead of remaining the same as assumed above). This implies that the second-period contest is more asymmetric if A wins and less asymmetric if B wins. Thus, A's incentive to win initially is even higher (compared with the case analyzed above) as it not only avoids the higher cost equilibrium but causes a lower cost equilibrium. Similarly, B's incentive and increase in effort will be lower than the case when losing maintains but does not exacerbate A's advantage.

4. *Endogenous advantage* – In the analysis above, I assume that whether or not advantage changes is endogenous but that the initial advantage and degree of advantage change is exogenous. I derive the effect of the initial level and degree of change on players' response to a possibility of change. This is to encompass a wide range of applications where the sources of advantages and disadvantages may be different determining the level and degree of change, which I take as given. For example, Corchón (2007) assumes that the second period advantage is the share of prize won in the first period and find similar advantage exacerbating effect under certain conditions. Alternatively, if we consider the labor market discrimination context and the source of advantage is more favorable beliefs about A's ability than B's ability. Then as B is less likely to win the initial contest due to unfavorable beliefs, winning signals that B is of a higher ability which compensates for the poorer beliefs and hence Bayesian updating will cause improved beliefs about B's ability for the next time that they compete.

5. *Additive advantage or disadvantage* – An additive advantage or disadvantage in winning probabilities is similar to an advantage in the prize from winning, which has been already discussed above.

Appendix C Additional Tables

Table 9: **Effect of reducible advantage on period 1 payoffs (Equal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reducible Advantage	-8.882**	-12.506***	-13.890***
	(4.167)	(4.569)	(4.160)
Advantaged			41.952***
			(4.027)
Advantaged × Reducible			5.603
			(5.930)
Mean [under fixed advantage]	132.39	91.65	
Controls	Yes	Yes	Yes
No. of Observations	880	880	1760

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 10: **Effect of reversible advantage on period 1 payoffs (Equal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reversible Advantage	-9.977**	-13.407***	-11.649***
	(4.995)	(4.815)	(4.519)
Advantaged			41.794***
			(3.957)
Advantaged × Reversible			2.428
			(6.687)
Mean [under fixed advantage]	132.39	91.65	
Controls	Yes	Yes	Yes
No. of Observations	700	700	1400

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 11: **Effect of reducible advantage on period 1 payoffs (Unequal time preferences)**

	Advantaged	Disadvantaged	Disadvantaged and Advantaged
Reducible Advantage	-23.970***	-15.018***	-14.633***
	(4.997)	(4.419)	(4.243)
Advantaged			53.037***
			(3.176)
Advantaged × Reducible			-9.263*
			(6.091)
Mean [under fixed advantage]	152.57	98.25	
Controls	Yes	Yes	Yes
No. of Observations	600	600	1200

Notes: Coefficients are based on panel regressions. Robust standard errors, clustered at the player level, are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 12: **Effect of reducible advantage on period 1 bids (Equal time preferences)**

	Advantaged	Disadvantaged	Advantaged and Disadvantaged
Reducible Advantage	12.561***	3.863	3.781
	(4.186)	(5.909)	(4.699)
Advantaged			-5.511
			(4.453)
Advantaged × Reducible			9.869*
			(6.234)
Mean [under fixed advantage]	41.30	39.37	
Controls	Yes	Yes	Yes
No. of Observations	88	88	176

Notes: Coefficients are based on OLS regressions. Robust standard errors are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 13: **Effect of reversible advantage on period 1 bids (Equal time preferences)**

	Advantaged	Disadvantaged	Advantaged and Disadvantaged
Reversible Advantage	16.097***	-7.469	-5.671
	(4.262)	(8.332)	(5.938)
Advantaged			-6.305
			(4.933)
favRev			21.831***
			(7.966)
Mean [under fixed advantage]	41.30	39.37	
Controls	Yes	Yes	Yes
No. of Observations	70	70	140

Notes: Coefficients are based on OLS regressions. Robust standard errors are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Table 14: **Effect of reducible advantage on period 1 bids (Unequal time preferences)**

	Advantaged	Disadvantaged	Advantaged and Disadvantaged
Reducible Advantage	6.516	20.133***	21.750***
	(6.730)	(8.038)	(6.124)
Advantaged			8.501*
			(6.177)
Advantaged × Reducible			-18.823**
			(8.877)
Mean [under fixed advantage]	34.04	28.61	
Controls	Yes	Yes	Yes
No. of Observations	60	60	120

Notes: Coefficients are based on OLS regressions. Robust standard errors are reported in parentheses. Controls include average bid in symmetric contest, prediction of match's bid, inverse of round, innate preference for winning, age, farsightedness and risk aversion. ***p-value < 0.01, **p-value < 0.05, and *p-value < 0.1, based on one-sided p-values.

Appendix D Screenshots of the players' screens

Screenshots of the advantaged player A's screen in the reducible disadvantage treatment when A's relative time preference or weight on period 2's payoff is 0.02.

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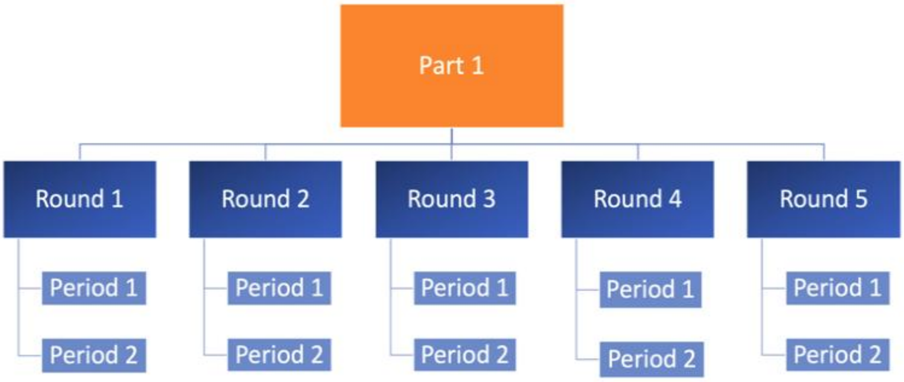
5 Rounds - 2 Periods



This part has **5** rounds (repetitions).
Each round consists of 2 periods.
One of the rounds will be picked at random for payment.
Each of the 5 rounds is equally likely to be the payment round.

You will be matched with a different participant in every round.

Next

Time left to complete this page: **0:55**

Bidding Choice

In every round of part 1, you will be randomly and anonymously matched with a different participant.

Both of you will get 100 points in every period.

One of you will win an additional prize of 100 points.

Both of you will bid for the prize.

You can choose how much out of 100 you want to bid. You will keep the rest.

Your chances of winning will depend on how much you and "the other participant" bid. The computer will pick who gets the prize accordingly.

One and only one of you will win the prize in every period.

Next

Time left to complete this page: **1:54**

Summary of Choices

In every period:

1. You have to predict the bid of 'the other participant'.
2. You have to choose and submit your own bid.

You will earn points (and hence money) based on these:

- From Bidding - You get the prize of 100 points if the computer picks you as the winner.
- From Prediction - You get a bonus of 25 points if the other participant's bid falls within 5 points of your prediction (± 5).
- You always keep the points that you do not bid.

Next

Time left to complete this page: **2:56**

Chances of winning

- For every point that you bid, the computer will put a **purple ball** in the 'Bid Bag'.
- For every point that the other participant bids, the computer will put a **green ball** in the 'Bid Bag'.

Then the computer will draw 1 ball at random from the bid bag.

- If the computer draws a **purple ball**, then you win.
- If the computer draws a **green ball**, then the other participant wins.

- Higher the number of purple balls in the Bid Bag, higher are your chances of winning.
- Higher the number of green balls in the Bid Bag, lower are your chances of winning.

$$\text{Your chance of winning} = 100 \times \frac{\text{Number of purple balls in the bid bag}}{\text{Total number of balls in the bid bag}}$$

Next

Time left to complete this page: **1:54**

Quiz

Please take the following quiz to make sure that you understand the rules:

If both you and your matched other participant make equal bids, what is your chance of winning the 100 points?

◯ 25% ◯ 50% ◯ 75%

If you bid more than your matched other participant, what is your chance of winning the 100 points?

◯ Higher than 50% ◯ 100%

- For every point that you bid, the computer will put a **purple ball** in the 'Bid Bag'.
- For every point that the other participant bids, the computer will put a **green ball** in the 'Bid Bag'.

Then the computer will draw 1 ball at random from the bid bag.

- If the computer draws a **purple ball**, then you win.
- If the computer draws a **green ball**, then the other participant wins.

- Higher the number of purple balls in the Bid Bag, higher are your chances of winning.
- Higher the number of green balls in the Bid Bag, lower are your chances of winning.

$$\text{Your chance of winning} = 100 \times \frac{\text{Number of purple balls in the bid bag}}{\text{Total number of balls in the bid bag}}$$

Next

Time left to complete this page: **0:55**

Yes! That's correct.

Quiz: What is your chance of winning if you and your matched other participant bid the same amounts?
Answer : 50%

Quiz: What is your chance of winning if you bid higher than your matched other participant?
Answer: Higher than 50%

Next

Time left to complete this page: **0:53**

Total Payoff

- Total payoff in a Round = Period 1 Payoff + Period 2 Payoff

For example, if your payoff is 100 points in period 1 and 100 points in period 2, your total payoff will be 200 points in the round.

Next

Time left to complete this page: **0:26**

Start

Please click 'Next' to continue to the first Round.

Next

Time left to complete this page: **3:48**

Round Number 1 of 5

Period 1

You: 1 point of bid = **1 Purple ball** in the Bid Bag. **The other participant:** 1 point of bid = **1 Green ball** in the Bid Bag.	One ball will be drawn at random to determine the winner of 100 points.

Use the sliders or boxes below to choose your prediction of the other participant's bid and your own bid:

Prediction of other participant's Bid: 16

Choose your Bid: 34

You keep = 66 points

If the other participant bids what you predicted, then:

There is **68% chance** of the following:	And **32% chance** of the following:
• You win and your period 1 payoff is **166 points** (Prize + what you keep)	• Your period 1 payoff is **66 points** (what you keep)

Submit bids

Time left to complete this page: **0:53**

Round Number 1 of 5

Period 1 Results

Ball drawn	**Green**
Winner	**The other participant**
Your chance of winning was	41.46 percent
Your bid	34.0 points
The other participant's bid	48.0 points
You Predicted	16.0 points
Prediction Bonus	0 points
Bidding Payoff	**66 points**
Total Period 1 Payoff	66 points

Next

Time left to complete this page: **3:48**

Round Number 1 of 5

Period 2

You: 1 point of bid = **1 Purple ball** in the Bid Bag. **The other participant:** 1 point of bid = **1 Green ball** in the Bid Bag.	One ball will be drawn at random to determine the winner of 100 points.

Use the sliders below to choose your prediction of other participant's bid and your own bid.

Prediction of other participant's Bid: 39

Choose your Bid: 34

You keep = 66

If the other participant bids what you predicted, then:

There is **47% chance** that:	And **53% chance** that:
• You win and your period 2 payoff is **166 points** (Prize + what you keep)	• Your period 2 payoff is **66 points** (what you keep)

Submit bids

Time left to complete this page: **0:51**

Round Number 1 of 5

Period 2 Results

Ball drawn	**Green**
Winner	The other participant
Your chance of winning was	52.31 percent
Your bid	34.0 points
The other participant's bid	31.0 points
You Predicted	39.0 points
Prediction Bonus	0 points
Bidding Payoff	**66 points**
Total Period 2 Payoff	66 points

Next

Time left to complete this page: **0:45**

Round Number 1 of 5

Period 2 Results

Ball drawn	**Purple**
Winner	You
Your chance of winning was	47.69 percent
Your bid	31.0 points
The other participant's bid	34.0 points
You Predicted	15.0 points
Prediction Bonus	0 points
Bidding Payoff	**169 points**
Total Period 2 Payoff	169 points

Next

Time left to complete this page: **0:50**

Results History

Round Number	Period 1 Bid	Period 1 Payoff	Period 2 Bid	Period 2 Payoff	Total Round Payoff (Period 1)+(Period 2)
1	34.0	66 points	34.0	66 points	132 points

Next

Time left to complete this page: **0:10**

You will now be randomly matched with another participant for the next round.

Please click 'Next' to continue to Round 2.

Next

Payoff from this Part

Time left to complete this page: **0:39**

The computer determined that the payment round will be **Round 5.**

Your total payoff in this Round was **350 points**

Please click 'Next' to continue to Part 2.

Results History

Round Number	Period 1 Bid	Period 1 Payoff	Period 2 Bid	Period 2 Payoff	Total Round Payoff (Period 1)+(Period 2)
5	25.0	175 points	25.0	175 points	350 points
4	25.0	175 points	25.0	75 points	250 points
3	25.0	75 points	25.0	75 points	150 points
2	25.0	75 points	25.0	175 points	250 points
1	34.0	66 points	34.0	66 points	132 points

Next

Time left to complete this page: **0:05**

Part 2

Next

Time left to complete this page: **0:56**

On the next page, there are many sliders.

Each of those needs to be set to a certain number.

For each slider that you set correctly, you will earn 1 point.

There will be no 'Next' button and you will have 60 seconds to set as many sliders correctly as you can.

Click 'Next' to start your 60 seconds.

Next

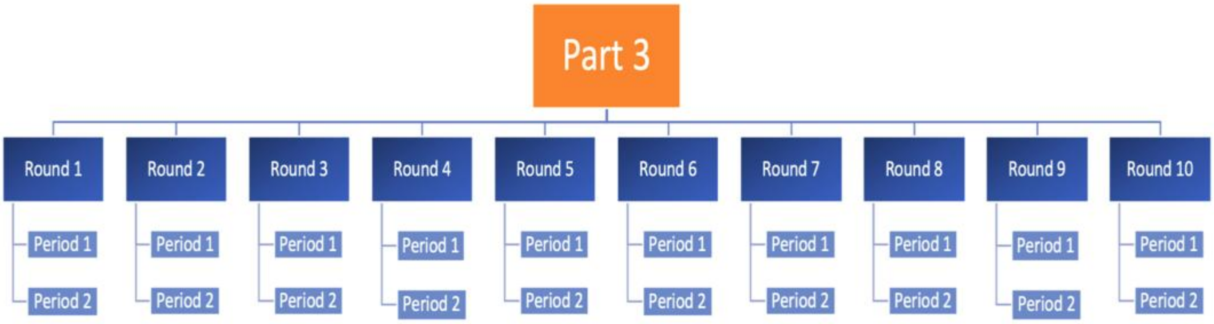
Time left to complete this page: **0:55**

Set the following sliders as below:

Set this to 50:
Set this to 20:
Set this to 65:
Set this to 17:
Set this to 34:
Set this to 89:
Set this to 75:
Set this to 8:
Set this to 50:
Set this to 31:
Set this to 18:
Set this to 74:
Set this to 100:
Set this to 41:
Set this to 18:
Set this to 92:
Set this to 23:
Set this to 56:
Set this to 14:
Set this to 83:
Set this to 30:
Set this to 5:
Set this to 45:
Set this to 71:
Set this to 66:
Set this to 31:
Set this to 10:
Set this to 80:
Set this to 28:
Set this to 13:
Set this to 54:
Set this to 87:

Time left to complete this page: **2:53**

10 Rounds - 2 periods



This part has **10** rounds (repetitions).
Each round consists of 2 periods.
One of the rounds will be picked at random for payment.
Each of the 10 rounds is equally likely to be the payment round.

You will be matched with a different participant in every round.

Next

Time left to complete this page: **2:55**

Bidding Choice

In every round of this part, you will be randomly and anonymously matched with another participant.

Both of you will get 100 points in every period.

One of you will win an additional prize of 100 points.

Both of you will bid for the prize.

You can choose how much out of 100 you want to bid. You will keep the rest.

Your chances of winning will depend on how much you and 'the other participant' bid. The computer will pick who gets the prize accordingly.

One and only one of you will win the prize in every period.

Next

Time left to complete this page: **2:56**

Summary of Choices

In every period:

1. You have to predict the bid of 'the other participant'.
2. You have to choose and submit your own bid.

You will earn points (and hence money) based on these:

- From Bidding - You get the prize of 100 points if the computer picks you as the winner.
- From Prediction - You earn 25 points if the other participant's bid falls within 5 points of your prediction (± 5).
- You always keep the points that you do not bid.

Next

Time left to complete this page: **2:55**

Types

There are two possible types for a participant - Type A and Type B

The computer will randomly assign either Type A or Type B to you.

There is a 50% chance that you will be Type A and 50% chance that you will be Type B.

Your type will remain the same in every round.

Next

Time left to complete this page: **2:56**

Your Type

You are **Type A** for all the 10 rounds in this part.

You will be matched with a participant of **Type B** in every round.

The type B participant you are matched with will change after every round.

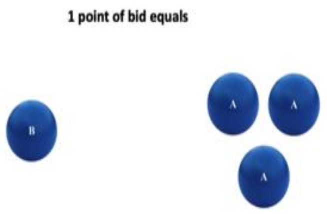
But your type will remain A throughout this part.

Next

Time left to complete this page: **2:54**

Period 1 Rules

- For every point that B bids, the computer puts 1 'B' ball in the Bid Bag.
- For every point that A bids, the computer puts 3 'A' balls in the Bid Bag.



Then the computer draws 1 ball at random from the bid bag.

- If the computer draws an 'A' ball, then A wins
- If the computer draws a 'B' ball, then B wins

- Higher the number of 'A' balls in the Bid Bag, higher are your chances of winning.
- Higher the number of 'B' balls in the Bid Bag, lower are your chances of winning.

$$\text{Your chance of winning} = 100 \times \frac{\text{Number of A balls in the bid bag}}{\text{Total number of balls in the bid bag}}$$

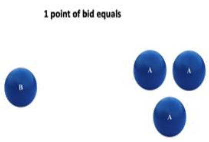
Next

Time left to complete this page: **2:48**

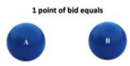
Period 2 Rules

(Depend on who wins in Period 1)

- **If A wins in period 1**, then period 2 rules are same as period 1 rules.
  - Every point that B bids, the computer puts 1 'B' ball in the Bid Bag.
  - Every point that A bids, the computer puts 3 'A' balls in the Bid Bag.



- **If B wins in period 1,** then in Period 2 :
  - Every point that B bids, the computer puts 1 'B' ball in the Bid Bag.
  - Every point that A bids, the computer puts 1 'A' ball in the Bid Bag.



Then the computer draws 1 ball at random from the bid bag.

- If the computer draws an 'A' ball, then A wins
- If the computer draws a 'B' ball, then B wins

- Higher the number of 'A' balls in the Bid Bag, higher are your chances of winning.
- Higher the number of 'B' balls in the Bid Bag, lower are your chances of winning.

$$\text{Your chance of winning} = 100 \times \frac{\text{Number of A balls in the bid bag}}{\text{Total number of balls in the bid bag}}$$

Next

Time left to complete this page: **2:28**

Summary of Rules

You are Type A. **Please take the following quiz to make sure that you understand the rules:**

What is your chance of winning if you and your matched type B participant bid the same amounts in:

Period 1?

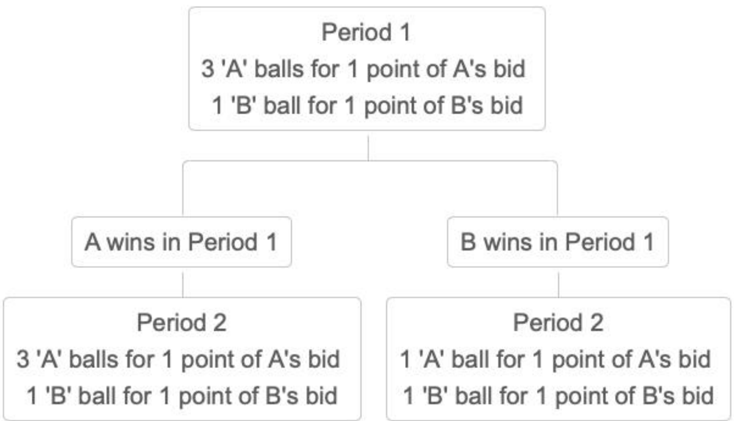
◯ 25% ◯ 50% ◯ 75%

Period 2, when you had won in period 1?

◯ 25% ◯ 50% ◯ 75%

Period 2, when you had lost in period 1?

◯ 25% ◯ 50% ◯ 75%



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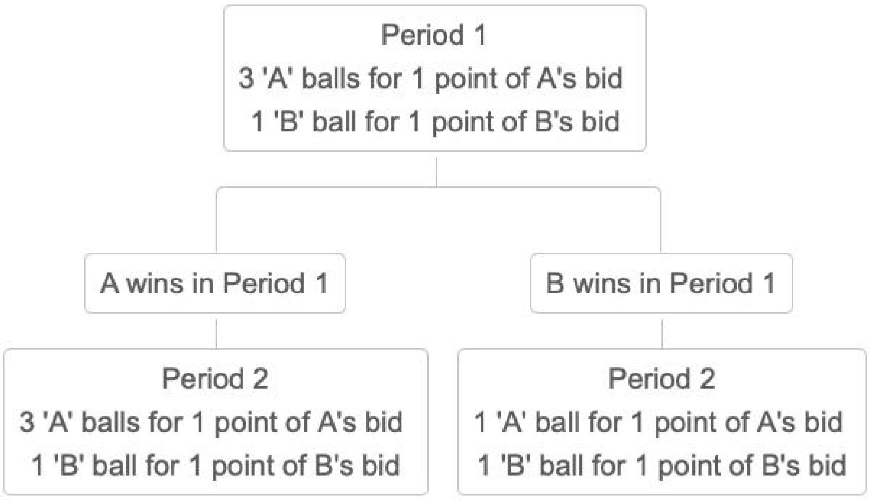
Time left to complete this page: **1:18**

Summary of Rules

You are Type A.

Oops! That's not right.



Quiz: What is your chance of winning if you and your matched type B participant bid the same amounts in:

Period 1?

75%

Period 2, when you had won in period 1?

75%

Period 2, when you had lost in period 1?

50%

Next

Time left to complete this page: **1:25**

Payoff

- For both types :
    - Total payoff in a Round = Period 1 Payoff + (5 * Period 2 Payoff)

For example, if your payoff is 100 points in period 1 and 100 points in period 2, your total payoff will be 600 points in the round.

Next

Time left to complete this page: **0:26**

Start

Click 'Next' to continue to the first Round.

Next

Time left to complete this page: **4:49**

Round Number 1 of 10

Period 1

You are Type A.	
You: 1 point of bid = 3 'A' balls in the bid bag	One ball will be drawn at random to determine
B: 1 point of bid = 1 'B' ball in the bid bag	the winner of 100 points.

Use the sliders or insert numbers below to choose and submit your Prediction of B's bid and your own Bid.

Prediction of B's Bid: 19

B keeps = 81 points

Choose your Bid: 28

You keep = 72 points

If B bids what you predict:

There is 82% chance of the following:	And 18% chance of the following:
• **You** win and **your period 1 payoff is 172 points** • In period 2, 1 point of your bid = 3 A balls in the bid bag.	• **Your** period 1 payoff is **72 points** • In period 2, 1 point of your bid = 1 A ball in the bid bag.

Payoff in a Round = Period 1 Payoff + (5 * Period 2 Payoff)

Submit bids

Time left to complete this page: **4:38**

Round Number 1 of 10

Period 1

You are Type B.

You: 1 point of bid = 1 'B' ball in the bid bag

A: 1 point of bid = 3 'A' balls in the bid bag

One ball will be drawn at random to determine the winner of 100 points.

Use the sliders or insert numbers below to choose and submit your Prediction of A's bid and your own Bid.

Prediction of A's Bid: 20

A keeps = 80 points

Choose your Bid: 27

You keep = 73 points

If A bids what you predict:

There is 31% chance of the following:

- **You** win and **your period 1 payoff is 173 points**
- In period 2, 1 point of A's bid = 1 A ball in the bid bag.

And 69% chance of the following:

- **Your** period 1 payoff is **73 points**
- In period 2, 1 point of A's bid = 3 A balls in the bid bag.

Payoff in a Round = Period 1 Payoff + (5 * Period 2 Payoff)

Submit bids

Time left to complete this page: **1:26**

Round Number 1 of 10

Period 1 Results

Ball drawn	**A ball**
Winner	**A**
Your chance of winning was	24.32 percent
Your bid	27.0 points
A's bid	28.0 points
You Predicted	20.0 points
Prediction Bonus	0 points
Bidding Payoff	**73 points**
Total Period 1 Payoff	73 points

A won in round 1.
So, in period 2 again: 1 point of A's bid = 3 A balls in the bid bag
1 Point of your Bid = 1 B ball in the bid bag.

Next

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Round Number 1 of 10

Period 2

You are Type B.

You: 1 point of bid = 1 'B' ball
A: 1 point of bid = 3 'A' balls (as A won in Period 1)

One ball will be drawn at random to determine the winner of 100 points in period 2.

Use the sliders or insert numbers below to choose and submit your Prediction of A's bid and your own Bid.

Prediction of A's Bid: 27
A keeps = 73 points

Your Bid: 35
You keep = 65 points

If A bids what you predict:

There is 30% chance of the following:

- **You** win and your period 2 payoff is **165 points**

And 70% chance of the following:

- **Your** period 2 payoff is **65 points**

Payoff in a Round = Period 1 Payoff + (5 * Period 2 Payoff)

Submit bids

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Round Number 1 of 10

Period 2 Results

Ball drawn	**A ball**
Winner	**A**
Your chance of winning was	26.12 percent
Your bid	35.0 points
A bid	33.0 points
You Predicted	27.0 points
Prediction Bonus	0 points
Bidding Payoff	65 points
Total Period 2 Payoff	65 points

Next

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Results History

(Your Type - A)

Round Number	Period 1 Bid	Period 1 Winner	Period 1 Payoff	Period 2 Bid	Period 2 Winner	Period 2 Payoff	Total Payoff (Period 1)+ (5*Period 2)
1	28.0	You	172 points	33.0	You	167 points	1007 points

Next

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You will now be randomly matched with another type B participant for the next round.

Please click 'Next' to continue to Round 2.

Next

Time left to complete this page: **1:44**

The computer determined that the payment round will be **Round 7.**

Your total payoff in this round was **1064 points**

Please click 'Next' to continue to Part 4.

Results History

(Your Type - A)

Round Number	Period 1 Bid	Period 1 Winner	Period 1 Payoff	Period 2 Bid	Period 2 Winner	Period 2 Payoff	Total Payoff (Period 1)+ (5*Period 2)
10	41.0	You	159 points	46.0	You	154 points	929 points
9	41.0	You	159 points	19.0	You	181 points	1064 points
8	41.0	You	159 points	19.0	You	181 points	1064 points
7	41.0	You	159 points	19.0	You	181 points	1064 points
6	41.0	You	159 points	19.0	You	181 points	1064 points
5	41.0	You	159 points	19.0	You	181 points	1064 points
4	41.0	You	159 points	19.0	You	181 points	1064 points
3	41.0	You	159 points	19.0	You	181 points	1064 points
2	41.0	You	159 points	19.0	You	181 points	1064 points
1	28.0	You	172 points	33.0	You	167 points	1007 points

Next

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Part 4

Next

Time left to complete this page: **4:55**

This Part is also a bidding task. There is only 1 trial of 1 round.

You have again been randomly matched with a participant

Both of you have 50 points to bid for a prize of 0.

Your chances of winning are given by your share in the total bid by you and your match.

You will see if you Won or Lost.

Please insert your bid:

Next

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Result

You Won **Your Bid = 2 points** **Your Payoff = 48 points**

Please press 'Next' to continue to the survey.

Next

Survey

Time left to complete this page: **2:49**

There are 6 options below. You can make further $ earnings based on one of these.

Choose the one that you most prefer.

The outcome of your choice will be decided by a random number generator when applicable.

Select the option you most prefer:

- (selected) Option 1: 50% chance of $1.40 and 50% chance of $1.40
- Option 2: 50% chance of $1.20 and 50% chance of $1.80
- Option 3: 50% chance of $1.00 and 50% chance of $2.20
- Option 4: 50% chance of $0.80 and 50% chance of $2.60
- Option 5: 50% chance of $0.60 and 50% chance of $3.00
- Option 6: 50% chance of $0.10 and 50% chance of $3.50

Next

Survey

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You chose Option 1.
Based on that, you earned $1.40.

The options were:

- Option 1: 50% chance of $1.40 and 50% chance of $1.40
- Option 2: 50% chance of $1.20 and 50% chance of $1.80
- Option 3: 50% chance of $1.00 and 50% chance of $2.20
- Option 4: 50% chance of $0.80 and 50% chance of $2.60
- Option 5: 50% chance of $0.60 and 50% chance of $3.00
- Option 6: 50% chance of $0.10 and 50% chance of $3.50

Next

Survey

Time left to complete this page: **2:50**

Please answer the following questions.

A bat and a ball cost 22 dollars in total. The bat costs 20 dollars more than the ball. How many dollars does the ball cost?

"If it takes 5 machines 5 minutes to make 5 widgets, how many minutes would it take 100 machines to make 100 widgets?" :

In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how many days would it take for the patch to cover half of the lake? :

Next

Puzzle

Time left to complete this page: **2:56**

Read the Instructions below to complete a puzzle on the next page.

You will be scored based upon the number of moves it takes you to finish. Completing the puzzle in fewer moves will earn you more money.

You will have 3 minutes to complete this puzzle.

You must complete the puzzle to earn any money. If the time runs out before you finish, you will get no payoff for the puzzle.

Plan your moves carefully before making them, as doing a move and then undoing it counts as two moves.

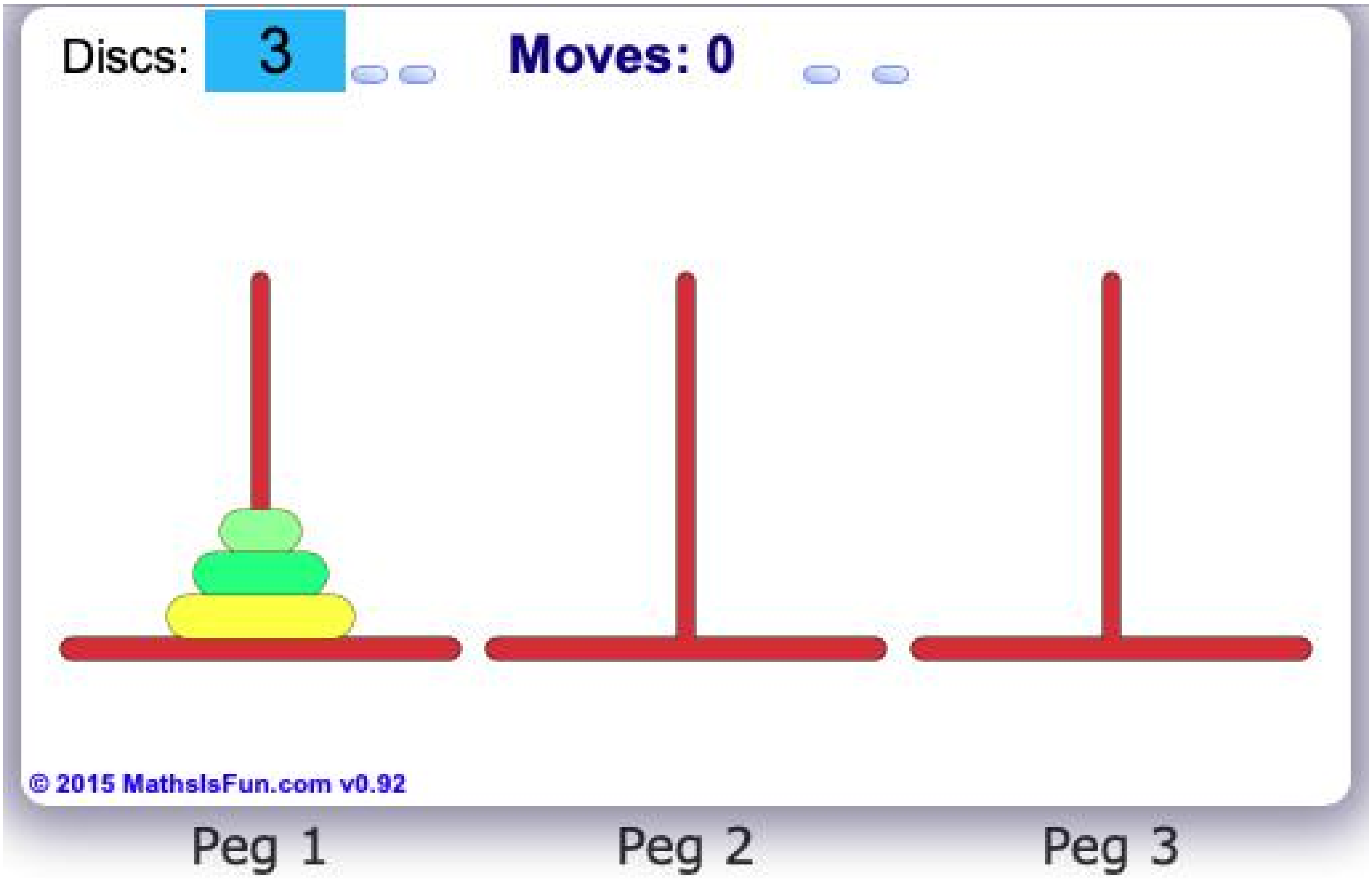
The object of the puzzle is to move all the disks from the leftmost peg 1 to the rightmost peg 3, so that the disks are arranged in the same size order, largest disk on the bottom, medium disk in the middle and smallest disk on top.

The rules are:

1. Only one disk can be moved from one peg to one other peg at a time.
2. A disk cannot be placed on a smaller disk.
3. Only the top disk on each peg can be moved.

Click the Next Button to complete the puzzle.

Next


Discs: 3
Moves: 0
© 2015 MathsIsFun.com v0.92
Peg 1
Peg 2
Peg 3

Time left to complete this page: **0:52**

Puzzle Result

You could not finish the game.
Your payoff from this is 0 points

Please press 'Next' to continue.

Next

Survey

Time left to complete this page: **4:48**

Please answer the following questions.

What is your age?

What is your gender identity?

○ Male ○ Female ○ Transmale ○ Transfemale ○ Queer/Noncomforming ○ Something else ○ Prefer not to say

Please rate your level of agreement with the following statement (7 means highly agree):"Competition brings out the best in me":

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7

Please rate your level of agreement with the following statement (7 means highly agree):"I love winning competitions irrespective of the value of the prize.":

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7

What was your main bidding strategy in Part 3?

- ○ I was trying to maximize my total expected payoff in every round
- ○ I was trying to maximize my probability of winning in each period
- ○ I was type A and I was trying to win in period 1, so that rules do not change in period 2
- ○ I was type B and I was trying to win in period 1, so that rules change in period 2
- ○ I was trying to have 50-50 chances of winning
- ○ I was trying to coordinate on low bids
- ○ I was bidding randomly
- ○ Other

Please elaborate on whatever you chose above, especially if you chose "Other":

Next

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Your total payoff in points is 1454 points = **$14.54.**
The participation fee is $7.00.

Thus, your total earning today is $21.54

You will receive your payment within 24 hours.

Thanks a lot for your participation.

Finish