2015

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Recommended Citation
Deck, C. and Jahedi, S. (2015). "Time Discounting in Strategic Contests," *Journal of Economics and Management Strategy* 24(1), Spring 2015, pp. 151-164. DOI: 10.1111/jems.12082

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Comments
This is the accepted version of the following article:

Deck, C. and Jahedi, S. (2015). "Time Discounting in Strategic Contests," Journal of Economics and Management Strategy 24(1), Spring 2015, pp. 151-164.

which has been published in final form at DOI: 10.1111/jems.12082

Time Discounting in Strategic Contests

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July 2011

Abstract

Results from individual-choice, time-discounting experiments reveal that people have short-run discount rates that can vary widely according to the setting. Little work has examined whether the same short-run discounting that is observed in individual-choice experiments extends to strategic settings. This paper uses a simple two-player contest, with a unique Nash equilibrium, to explore the extent to which people discount in games, and whether they anticipate that others will do so. We find that people do not significantly discount the future, nor do they act as if others will.

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1 Introduction

Most economic decisions involve at least some tradeoff between current and future consumption. Important decisions in the realm of health, education, and savings, are all determined in part by the extent to which people value today versus the future. Research on time discounting has focused on individual decisions (see Andreoni and Sprenger 2010 for a discussion), but there are many situations in which intertemporal decisions are made in strategic settings. This paper looks at the interplay of subjective discounting and strategic behavior in one such area, namely contests. In contests with a time-component, each party must anticipate the cost of delay to the other party and make investment decisions accordingly. Three common examples in the contest literature are patent races, sports competitions, and politics. All three regularly involve decisions where costs are incurred in advance of a future reward, and where each party must anticipate their rival's discounted value of the future prize. Firms make current investments in R&D based upon the anticipated future actions of their rivals and market conditions. Sports teams make hiring decision and engage in costly training prior to entering a tournament. Political candidates campaign well in advance of elections, which themselves are well in advance of the winner taking office.

In order to measure *individual* discount rates, respondents are generally asked a series of binary choice questions that determine the amount m that makes them indifferent between receiving x today and $x + m$ in a future period. The evidence suggests that beyond the traditional model of exponential discounting, people exhibit a taste for immediate gratification, or "present-bias." That is, researchers consistently find heavy discount factors (about 0.6) when people are choosing between an immediate reward and a future reward, whereas they find much more patient behavior (discount factors close to 1) when people are choosing between two future rewards (Frederick, Loewenstein, O'Donoghue 2002). Recent research suggests that revealed discount rates are a result of multiple systems in the brain interacting with one another (Shefrin and Thaler 1981, Bernheim and Rangel 2004, O'Donoghue and Loewenstein 2004, Fudenberg and Levine 2004). It appears that present-bias is linked to the emotional (limbic) system of the brain, which holds a high value for immediate rewards. In contrast, patience is linked to the analytical (pre-frontal cortex) system in the brain, which seems to value rewards more constantly across time. To model behavior across time, it is therefore important to understand the situations that lend themselves to greater time discounting.

In individual decision choices, it has been shown that discount factors vary across elicitation methods (Andersen et al 2008, Andreoni and Sprenger 2010, Takeuchi 2011, Laury, McInnes, Morgan, and Swarthout 2011) and can depend on context and other psychological factors (Shiv and Fedorikhin 1999, McLure, Laibson, Loewenstein, and Cohen 2004). All of these papers, however, arrive at the same general finding: in individual choice settings, people heavily discount the immediate future and only slightly discount the distant future more. Despite this finding, researchers of interactive environments, continue to use exponential discounting as the standard discounting method. In fact, some theoretical literature has argued that quasi-hyperbolic discount factors cannot be sustained in interactive environments. For instance, Ainslee (2001) argues that people form rules when interacting with others that mitigate their ability to fall victim to a money-pump while Laibson and Yariv (2007) argue that competition eliminates any rents that can be extracted from people with such preferences. We believe our paper is the first to examine how time-discounting is manifested in interdependent games. We ask whether people exhibit the same heavy discount factors in strategic settings as they do in individual choice settings, and whether they anticipate that their opponents discount so heavily. There are two reasons to believe that people may have different discount rates in games: (1) the tradeoff between receiving money immediately and in the future is less salient in a game than when a person is asked directly in part because of the inherent strategic uncertainty regarding the behavior of the other players, and (2) the brain's analytical abilities are called upon in strategic settings since people must think about how others will behave, and what others, in turn, think about their behavior.[1]

To explore time discounting in a strategic environment, we design an experiment in a simple setting: a two player contest with a time dimension and a single winner. Numerous papers have considered contests from both theoretical and behavioral perspectives (see Congleton, Hillman, and Konrad, 2008 for a review). The two prevalent streams of single winner contests are all-pay auctions and Tullock contests. In all pay auctions, the winner is determined by which party invests more. The optimal behavior in such a contest involves playing a mixed-strategy equilibrium (Hillman and Riley, 1989; Baye, et al., 1993). By contrast, in Tullock (1980) contests the likelihood of winning is proportional to the amount invested and there is a unique pure strategy equilibrium.[2] For this reason, we use a Tullock contest with a proportional probability of winning in our experiments for simplicity.

We depart from previous contest experiments by adding an element of timing into the contest by varying when the prize is allocated (immediately vs. the future). When the timing of prizes vary across contest participants, a strategic factor is introduced in the

[1]Past research has shown that if one region of the brain is occupied, it affects overall decision making. For instance, Shiv and Fedorikhin (1999) tested the two-self model by looking to see what happens to the long-run self's ability to regulate the short-run self when the long-run self is burdened with an occupying task memorizing a seven-digit number. The authors discover that people act more impatiently (choose chocolate cake over a bowl of fruit) when their long-run self is impaired in this way (memorizing a seven-digit number vs. a three-digit number).

[2]The all pay auction with a deterministic outcome is a limiting case of a Tullock (1980) contest.

game. The contest literature has nominally focused on situations where the timing of the prize is independent of who wins the contest. However, work on asymmetric prize values more generally (Nti, 1999; Baik 2004) sheds light on the predicted behavior of agents who are making decisions at different points in time. The general result with asymmetric prizes is that the player with the higher value invests more. Further, as the high value increases, that player will invest more while the low value player becomes discouraged and invests less.

The methodology of experimental economics offers an ideal tool for this type of work because the researcher can exogenously manipulate the timing and size of the prize payment and can control how investment affects the likelihood of winning. By varying the timing of the prize between the present and the future, the value to the bidder of winning is altered when the person significantly discounts the future. Our experiment thus provides a joint test of how much people discount and whether they strategically take advantage of others' discounting.

2 Experimental Design

Our experimental design uses a proportional contest where two players, i and j, bid for a prize, $P = \$5$. Each player is endowed with $E = \$5$, and must forfeit any amount bid regardless of whether or not the player actually wins the prize. Let bid_i denote player i's bid. The probability that a player wins the prize equals $\frac{bid_i}{bid_i+bid_j}$. Ignoring the timing of prize payments, player i's objective is to maximize $E - bid_i + P \cdot \frac{bid_i}{bid_i+bid_j}$. In the symmetric, two-player, single-period contest, the optimal bid of each player is $bid^* = \frac{P}{4}$. In the experiments, we impose the constraint that $bid_i \leq E$ to avoid a loss of experimental control associated with bankruptcy.[3] This constraint should not be binding because $P = E$.[4]

To introduce time discounting, we employ a 2x2 between subjects experimental design. The first dimension is the date which each player receives the prize if she wins (now or in one week) and the second dimension is the date which their rival receives the prize (now or in one week). Since our experiments only involve a single future period one week out, we simply denote the discount rate over this interval as $\tilde{\beta}$.[5]. If people heavily discount the near

[3]IRB constraints do not allow a participant to earn less than \$0 in the study. This means that all nominal losses result in the same payoff to the subjects, namely \$0, and therefore subjects would not incur a real marginal loss from a further reduction in their nominal earnings.

[4]It is possible that the subject receives a utility from winning the prize separate from the value of the prize itself, in which case this condition is not sufficient to ensure the constraint is not binding. This value would have to be intrinsic to the subject as there was no public announcement or indication of who won a contest. Further, the size of the value of winning would have to be relatively large for the constraint to bind because the optimal bid is much lower than E.

[5]We do not try and differentiate whether people discount hyperbolically or exponentially. We simply look to see whether the heavy short-run discount factors found in many other studies is found here. Under the

future (i.e. $\tilde{\beta}$ is substantially less than 1 as previous individual choice research suggests), we should observe bids that are much lower for the same nominal prize received in the future than if it was received today. If on the other hand people do not heavily discount the future (i.e. $\tilde{\beta}$ is close to 1), we would expect to observe little to no difference in bidding behavior based upon when the bidder would receive the prize.[6] If people anticipate that others heavily discount the future, we should observe bids that are lower when one's opponent is receiving the prize in the future as compared to when the opponent would receive the prize today. If people do not anticipate that their rivals heavily discount the near future, then the timing of the opponent's prize should have no effect on bidding behavior.

In the situation where both parties are paid now, the predicted behavior is as described above, namely $bid_i^* = \frac{P}{4}$. When both parties are paid in the future, the objective function for player i becomes $E - bid_i + \tilde{\beta}P \cdot \frac{bid_i}{bid_i+bid_j}$ and the optimal bid becomes $bid_i^* = \tilde{\beta} \cdot \frac{P}{4}$.[7] This result is intuitive, if the receipt of the prize is pushed into the future, the prize is worth less to both parties and people should bid less for it. If the future is discounted by $\tilde{\beta}$, the bids are as well.

When player i would receive the prize now, but player j would receive the prize in one week, then the players no longer have symmetric objective functions and resulting first order conditions. In this case, player i's first order condition is $-1+bid_j \cdot \frac{P}{(bid_i+bid_j)^2} = 0$ while player j's first order condition is $-1 + bid_i \cdot \frac{\tilde{\beta}P}{(bid_i+bid_j)^2} = 0$. The solution to these two simultaneous equations is $bid_i^* = \frac{\tilde{\beta}P}{(1+\tilde{\beta})^2}$ and $bid_j^* = \frac{\tilde{\beta}^2P}{(1+\tilde{\beta})^2}$. This means that the person who receives the discounted prize in the future bids $\tilde{\beta}$ of what the person who would receive it now bids, $bid_j^* = \tilde{\beta} \cdot bid_i^*$.

The bidding best-response function denotes how a person's optimal bid should vary according to the rival's bid. As shown in Figure 1, the best response curve depends on how much the bidder discounts the prize. If the prize is received today (or the future is not significantly discounted), bids should be higher than if the prize is received in the future and

standard exponential discounting model $u(c_t) = \beta^t u(c_0)$ where $u(c_t)$ denotes the utility from receiving c at time t. With this framework, $\tilde{\beta} = \beta^t$. Under hyperbolic discounting $u(c_t) = \beta\delta^t u(c_0)$ for $t > 0$ where δ acts as a standard exponential discount factor and β captures a present bias. With this framework, $\tilde{\beta} = \beta\delta^t$

[6]It is possible that people are impatient in intertemporal contests, but appear to have a discount factor near 1 due to confusion, experimenter demand effects, or some other explanation. These are potential concerns in any experiment and we take the usual precautions to reduce these alternative explanations as much as possible.

[7]In this analysis, it is assumed that each player discounts the future by the same rate, $\tilde{\beta}$, and has correct beliefs about the other player's discount factor. Of course, it is possible that the players have differing discount factors or inaccurate beliefs about the other player's discount factor. However, given a discount rate for each player and a belief about their rival's discount rate, the same strategic principles hold: both players will want to decrease their bid in response to 1) receiving the prize further in the future or 2) their opponent receiving the prize further in the future.

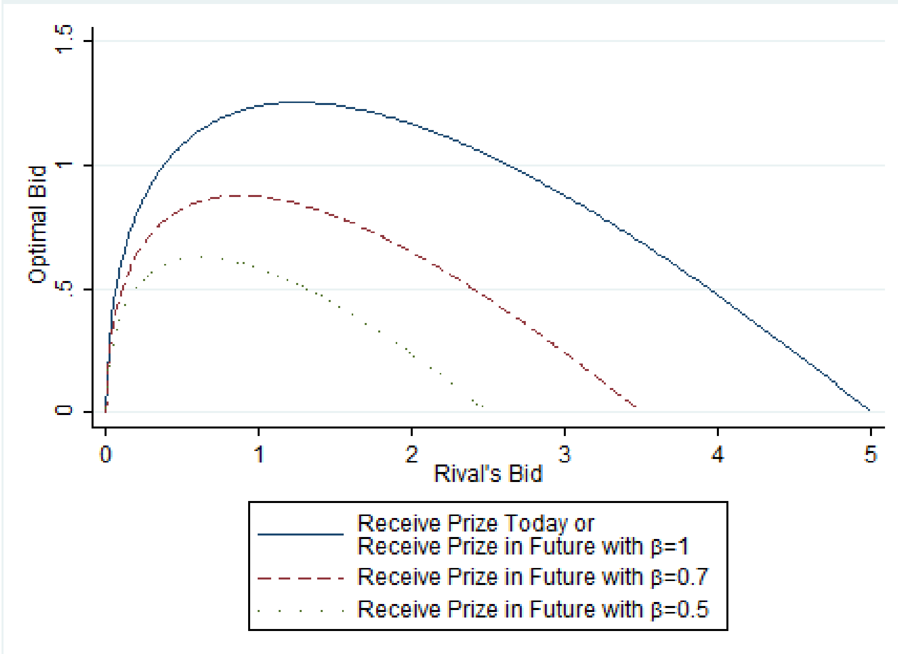

Figure 1: **Bidding Best-Response Function.**

its value is discounted. Given that P =\$5, the highest value a person should ever bid in this auction is\$1.25, occurring when the bidder does not discount the prize and is in response to an equal bid by the rival. If the rival bid is low, the best response is to bid slightly higher than the rival. This ensures the player has a majority chance of winning the object at a low cost. If the rival bid is high, the best response is again to bid low, because escalation becomes too costly.

With the assumption that $\tilde{\beta} \in (0, 1)$ we have a strict ordering of equilibrium bidding in each situation regardless of P. The size of the difference depends on $\tilde{\beta}$. Table 1 provides the predicted bid by treatment and the relative ranking between treatments. Table 1 also gives the optimal bid if $\tilde{\beta} = 0.5$, 0.7, and 1 for $P = \$5$.[8] At this prize size, the timing of when the rival would receive the prize has only a small effect on predicted bids, but the timing of one's own receipt of the prize does a have a substantial impact if people exhibit discounting.[9]

The paid experiments were conducted during two 120 person sections of a principles of economics course at a state university. The course instructor was not one of the researchers and the participants were assured that the instructor would not be informed of what any participant did. Our use of a classroom is non-standard, and concerns can be raised that

[8]Previous individual choice experiments vary in their estimates of $\tilde{\beta}$ but a value of 0.6 is typical.

[9]To create separation between optimal bids due to the timing of the rival's prize would require considerably larger prize amounts. For example, if $\tilde{\beta}$= 0.7 and $P = \$100$ the predicted bid for someone who would receive the prize now would only vary by \$0.80 based upon the timing of the rival's prize. Very large stakes experiments might be worthwhile if we observed present bias, but as discussed in the next section we do not.

Table 1: **Equilibrium Bids by Treatment Ranked in Descending Order.**

Own Prize Received	Rival's Prize Received	Bid	Bid if $P = \$5$ $\tilde{\beta} = 0.5$	$\tilde{\beta} = 0.7$	$\tilde{\beta} = 0.1$
Now	Now	$\frac{P}{4}$	\$1.25	\$1.25	\$1.25
Now	In one week	$\frac{\tilde{\beta}P}{(1+\tilde{\beta})^2}$	\$1.11	\$1.21	\$1.25
In one week	In one week	$\frac{\tilde{\beta}P}{4}$	\$0.63	\$0.88	\$1.25
In one week	Now	$\frac{\tilde{\beta}^2P}{(1+\tilde{\beta})^2}$	\$0.56	\$0.85	\$1.25

students are apt to act in a way so to please the instructor.[10] However, we felt that the advantage the classroom served to minimize the transaction costs associated with returning for payment at a later date was the dominant concern. To illustrate how use of the lab can pose greater difficulties, suppose that some subjects were uncertain about their ability to return for their future payments. This uncertainty would manifest itself into overbidding on current prizes, implying much higher future discounting.[11]

At the start of class a copy of a consent form was projected onto a screen at the front of the class. Students were informed of how the experiment would be conducted and large identical envelopes were passed out. Students who wished to participate were instructed to take an envelope.[12] Inside the large envelope were two normal sized white envelopes and the directions/response form. A copy of the directions/response form is included in the appendix. One of the envelopes was labeled "Today's Money" and the other was labeled "Next Week's Money." Participants wrote their names on both envelopes and completed the response form and then placed these items back inside the large envelope. The large envelopes were then collected and taken to another room. The data collection process took approximately 10 minutes at the start of class, after which the instructor lectured as normal.

[10]This is an argument similar to that of demand effects in the lab, and is ultimately a question of dominance (Smith 1982). Eckel and Grossman (2000) show that students in the classroom give more to charity than do traditionally recruited students in the lab for each of two dictator treatments. However, the difference between treatments was not affected by the subject pool. As argued by Zizzo (2010), demand effects are problematic to the degree they vary with the treatments.

[11]As described by Andreoni and Sprenger (2010), equating the transaction costs and credibility of payment between current and future periods is important when measuring subjective discount rates because unanticipated (by the experimenter) additional costs or uncertainty associated with future payments can mistakenly be interpreted as greater discounting. Kirby and Marakovic (1995) minimize transaction costs by delivering the rewards in person on the night it is due. Coller and Williams (1999) control for this problem by using multiple future periods, so any uncertainty about the future is equally applied to both periods. Horowitz (1991), like us, uses the classroom.

[12]Subjects who did not want to participate could either not take an envelope or take an envelope and simply not fill out the required information which included name, student ID number, and bid. Less than 5% of the students chose not to participate.

While the students were in lecture, the envelopes were sorted by treatment, paired randomly, and the contest winner was determined. Cash payments were then stuffed into the appropriately labeled envelopes for each person.[13] So that no one could tell which treatment anyone else was in or who won a contest, everyone received a $1 payment in their "Next Week's Money" envelope in addition to any prize payment. This procedure also equalized any perceived risk or burden associated with having to interact with the experimenters twice across treatments.[14] The envelopes labeled "Today's Money" were taken back to the classroom 5 minutes before the end of the period and handed out to each person. The envelopes labeled "Next Week's Money" were brought back to class the following week and given out in a similar procedure. Care was taken to select weeks that were not expected to have a high demand for money or missing class such as just after an exam or close to a holiday.

3 Experimental Results

A total of 183 subjects participated in this study.[15] Table 2 gives the average bid by treatment and Figure 2 shows the kernel density of bids by treatment. Average bids are all substantially (and significantly) greater than the predicted values in Table 1. From Figure 2, the attraction to integer bids is apparent from the local maxima at $1, $2, and $3. Importantly, these patterns are similar to previous results (Millner and Pratt 1989; Davis and Reilly, 1998; Potters et al., 1998; Gneezy and Smorodinsky, 2006; Sheremeta, 2010a, 2010b) suggesting that our results are consistent with previous contest experiments. For our purposes it is not important whether or not people are bidding according to the equilibrium predictions. Rather the point of interest is whether or not bids vary with the timing of the prize. The answer is no: average bids also show little evidence of heavy discounting nor any anticipation of such discounting in rivals.

The Bidding behavior when both players are bidding for the prize today (average bid of $2.05) is similar to the bidding behavior (average bid =$2.15) when both players are bidding to receive the prize is in one week, (z=0.348, p-value = 0.728). The average bid of those expecting the prize today did not differ significantly from the average bid of those expecting

[13] This process was quite labor intensive and would not have been possible without the help of a small army of colleagues and graduate students who went through training in advance of the experiment.

[14] Previous research has focused on the perceived risk of the subjects that the future payment would not be delivered or the transaction costs of having to deal with the experimenter multiple times (see Andreoni and Sprenger 2010). Our use of a class experiment was intentionally designed to counteract those effects.

[15] Due to the classroom procedures discussed in the previous section and the need to include everyone who wished to participate, we could not ensure that every subject could be matched with a unique rival. In the instances in which a subject had no rival, they paid their bid and received the prize as though their rival had bid 0. Subjects were not informed of this rule.

Table 2: **Average Bid and Standard Deviations by Treatment.**

		Rival Receives Prize	
		Now	In one week
Player	Now	\$2.05	\$2.35
Receives		(1.41)	(1.77)
Prize	In one week	\$2.18	\$2.15
		(1.37)	(1.53)

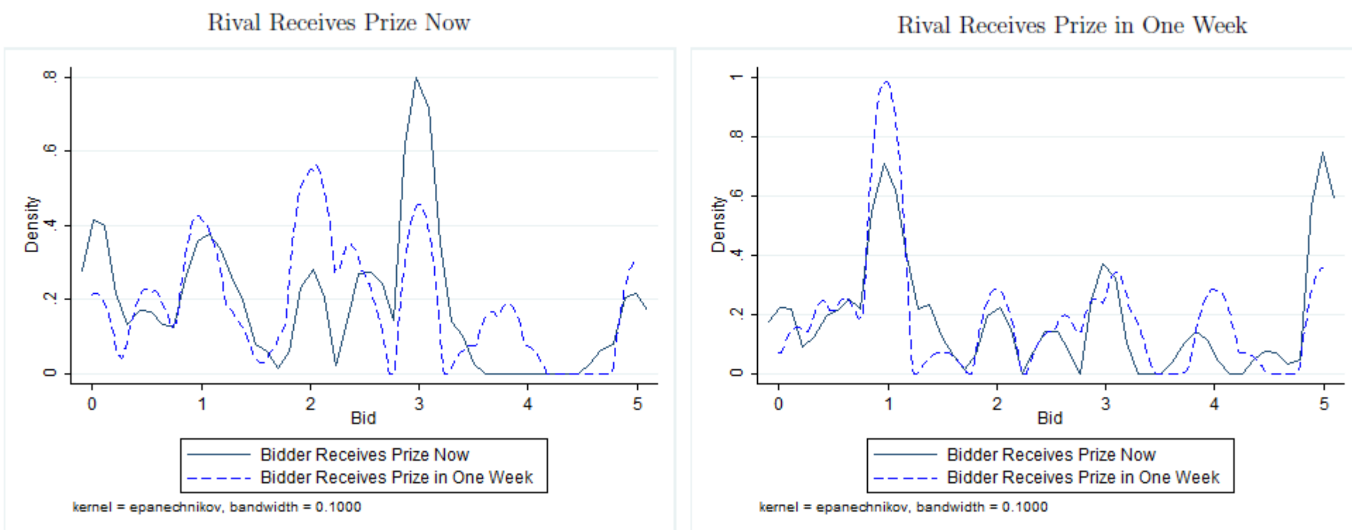

Figure 2: **Kernel Density of Bids by Treatment.**

to receive the prize in the future.

Furthermore, conditional on when the rival receives the prize, the amount bid does not depend upon when the player would receive the prize. For those whose rival received the prize immediately, the difference in the average bid between those receiving the prize now and in the future was \$0.13, an insignificant difference (z=0.468, p-value =0.639). This change is nominally in the opposite direction from that predicted assuming present bias. For those whose rival would receive the prize in one week, the difference in average bids between those who would receive the prize now and in one week was \$0.20, an insignificant difference (z=0.578, p-value =0.563). There was also no deference in the distribution of bids: (1) conditional on the rival receiving the prize today, the Kolmogorov-Smirnov test shows that the distributions of bids did not significantly differ depending on when one received the prize (p-value = 0.951) and (2) conditional on the rival receiving the prize in the future, the Kolmogorov-Smirnov test shows that the distributions of bids did not significantly differ depending on when one received the prize (p-value = 0.704). We find no evidence of present bias in the bidding behavior of the players.

We also find no evidence that people expect their rivals to heavily discount the future. Conditional on when players would receive the prize themselves, the amount bid does not depend upon when their rival would receive the prize. For those who received the prize immediately, the average bid was \$2.05 when the rival would receive the prize immediately and \$2.35 when the rival would receive the prize in one week, an insignificant difference (z=-0.913, p-value =0.361). This difference is nominally in the opposite direction from that predicted if people anticipate their rivals are heavy discounters. For those who received the prize in one week, the average bid was \$2.18 when the rival would receive the prize immediately and \$2.15 when the rival would receive the prize in one week, an insignificant difference (z=0.101, p-value =0.919). However, there is only a small nominal change in optimal bids except in cases of extreme present bias or extremely large stakes, so this is not too surprising.[16] Conditional on own bids, we also tested whether there was a difference in the bid distributions due to when the rival was receiving the prize. The Kolmogorov-Smirnov test shows there was no significant difference in these two distributions: (1) conditional on the bidder receiving the prize today (p-value = 0.226) and (2) conditional on the receiving the prize in the future (p-value = 0.275).

Together, these findings suggest that in simple strategic contest settings, people do not seem to have large discount rates. In fact, it seems that behavior is more consistent with exponential discounting than with hyperbolic discounting, so that a short delay in the reward has little effect on perceived value. This is consistent with Andreoni and Sprenger (2010) who also finds little evidence of large discounting in a situation that could be described as more analytical than emotional.[17]

4 Conclusion

In individual settings, it has been shown that people heavily discount the future. It is thought that this hyperbolic discounting is the result of the interaction between the analytical and emotional systems of the brain. When the emotional system, which seeks immediate rewards, is aroused, then people appear impatient. When the analytical system, which uses reason to make tradeoffs, is aroused, then people appear more patient. Within the context of individual choice decisions, evidence indicates that stimulating one of the systems greatly

[16] See footnote 9 for a discussion of how large the stakes would have to be to separate bids as the timing of the rival's prize changes at previously estimated levels of present bias.

[17] Our results are also consistent with previous work by Anderson and Stafford (2003) and Anderson and Freeborn (2010) which find little evidence of discouragement in contests with asymmetric values.

affects observed time discounting.

This paper is a first attempt to see how time discounting is affected when made in a strategic setting. We measure discounting using a simple game: a two-player Tullock contest with a single winner and unique Nash equilibrium bidding strategies, where the timing of prizes varies. The choice made in this setting differs from the typical direct elicitation choice in that (1) the tradeoff between money today and money in the future is less salient and (2) the choice involves secondary analytical aspects which require attention.

We find no evidence that bidders in our experiment excessively discount the future nor do we find evidence that they expect their rivals do so. Instead, we find behavior that is similar to what has been observed in other contest experiments, namely widely dispersed bids that are on average greater than what is predicted by the unique Nash equilibrium. Our results can be interpreted in a number of ways. First, the results could be seen as casting doubt on the model of hyperbolic discounting, consistent with the message of Andreoni and Sprenger (2010). A second explanation is that the today reward is uncertain, and it has been shown in situations with high uncertainty, participants do not show heavy discounting (Andersen 2008, Laury et al 2011). If this was the case, it would suggest that even in mildly uncertain environments, present bias may disappear. Finally, an alternative explanation is that the strategic considerations of the contest cause the analytical (pre-frontal cortex) portion of the brain to dominate the emotional (limbic) system making people appear more patient.[18]

Admittedly, this is only a single experiment, yet the implications it has about time discounting in everyday strategic settings is both important and interesting. For instance, a major criticism against hyperbolic discounting is that if people actually discounted so heavily, others could use this fact to take advantage of them in various transactions. Our findings show that this is not necessarily the case. In our experiment, when participants played a strategic game, they not only seemed to exhibit little discounting, but they also expected that others do the same. Further research is needed to explore the robustness of this finding. In particular we believe that other strategic games (both easy and hard) need to be studied to see whether discounting systematically depends on the complexity of the game and thus the amount of analytical thinking required.

[18]Similar results could also arise in individual choice experiments that call upon the pre-frontal cortex. For example, the convexification process of Andreoni and Sprenger (2010) may cause the analytical portion of the brain to dominate, thus explaining their findings.

References

[1] Ainslie, George,*Breakdown of Will,* Cambridge, UK: Cambridge University Press, 2001.

[2] Anderson, L.A., & Freeborn, B.A. (2010). "Varying the Intensity of Competition in a Multiple Prize Rent Seeking Experiment." *Public Choice*, 143, 237-254.

[3] Anderson, L.A., & Stafford, S.L. (2003). "An experimental analysis of rent seeking under varying competitive conditions." *Public Choice*, 115, 199-216.

[4] Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, and E. Elisabet Rutstrom. "Eliciting risk and time preferences." *Econometrica*, 76: 583-618, 2008.

[5] Andreoni, J. and C. Sprenger (2010) "Estimating Time Preferences from Convex Budgets." Working Paper, UCSD.

[6] Ariely, Dan and Klaus Wertenbroch. 2002. "Procrastination, Deadlines, and Performance: Self-control by Precommitment." *Psychological Science*, 13(3): 219-224.

[7] Ariely, Dan, Gneezy, Uri, Loewenstein, George F. and Mazar, Nina. "Large Stakes and Big Mistakes." *Review of Economic Studies*, Vol. 76, No. 2, pp. 451-469, April 2009.

[8] Ausubel, Lawrence. 1999. "Adverse Selection in the Credit Card Market." Working Paper, University of Maryland.

[9] Baik, K. 2004 "Two-Player Asymmetric Contests with Ratio-Form Contest Success Function." *Economic Inquiry* 42(4), pp-679-689.

[10] Baye, M., Kovenock, D., & de-Vries, C.G. (1993). "Rigging the lobbying process: an application of the all-pay auction." *American Economic Review*, 83, 289-294.

[11] Bernheim, B.D., and Antonio Rangel, 2004, "Addiction and cue-triggered decision processes." *American Economic Review*, 94(5), 1558-1590

[12] Cagetti, Marco, "Wealth Accumulation Over the Life Cycle and Precautionary Savings," *Journal of Business and Economic Statistics*, 2003, 21 (3), 339-353.

[13] Coller, Maribeth and Melonie B. Williams. "Eliciting individual discount rates." *Experimental Economics*, 2:107-127, 1999.

[14] Congleton, Hillman, and Konrad, 2008. "40 Years of Research on Rent Seeking" Springer-Verlag, Berlin.

[15] Davis, D., & Reilly, R. (1998). "Do Many Cooks Always Spoil the Stew? An Experimental Analysis of Rent Seeking and the Role of a Strategic Buyer." *Public Choice*, 95, 89-115.

[16] DellaVigna, Stefano and Ulrike Malmendier. 2006. "Paying Not to Go to the Gym." *American Economic Review*, 96(3): 694-719.

[17] Duncker, K. (1945). "On problem solving." *Psychological Monogrpahs*, 58. Whole no. 270.

[18] Eckel, C. and Grossman, P. "Volunteers and Psuedo Volunteers: The Effect of Recruitment Method in Dictator Experiments." *Experimental Economics*, 3(2), 107-120.

[19] Frederick, Shane and George Loewenstein, "Hedonic Adaptation," in Daniel Kahneman, Ed Diener, and Norbert Schwarz, eds., *Well-Being:The Foundations of Hedonic Psychology*, New York, NY, US: Russell Sage Foundation, 1999, pp. 302-329.

[20] Frederick, Shane, George Loewenstein, and Ted ODonoghue. (2002) "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature*, 40 (2), 351-401.

[21] Fudenburg, Drew and David K. Levine, 2006, "A dual-self model of impulse control." *American Economic Review*, 96(5), 1449-1476.

[22] Glucksberg, S. 1962. "The influence of strength of drive on functional fixedness and perceptual recognition." *Journal of Experimental Psychology*, 63, 36-41.

[23] Gneezy, U., & Smorodinsky, R. (2006). "All-Pay Auctions: An Experimental Study." *Journal of Economic Behavior and Organization*, 61, 255-275.

[24] Gourinchas, Pierre-Olivier and Jonathan A. Parker, "Consumption Over the Life Cycle," *Econometrica*, 2002, 70 (1), 47-89.

[25] Harrison, Glenn W., Morten I. Lau, and Melonie B. Williams. (2002) "Estimating individual discount rates in Denmark: A Field experiment," *American Economic Review*, 92 (5), 1606-1617.

[26] Hillman, A. & Riley, J.G., (1989). "Politically contestable rents and transfers." *Economics and Politics*, 1, 17-40.

[27] Horowitz, John K. "Discounting Money Payoffs: an Experimental Analysis." in Handbook of Behavioral Economics, JAI Press Inc, 1991, Volume 2B, 309-324.

[28] Kirby, Kris N. and Nino N. Marakovic. 1995. "Modeling Myopic Decisions: Evidence for Hyperbolic Delay-Discounting with Subjects and Amounts, *Organizational Behavior and Human Decision Processes*. 64, p.22-30.

[29] Laibson, David. (1997) "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics*, 112 (2), 443-477.

[30] Laibson, David, Andrea Repetto, and Jeremy Tobacman. (2003) "A debt puzzle," in Philippe Aghion, Roman Frydma, Joseph Stiglitz, and Michael Woodford, eds., Knowledge, information and expectation in modern economics: In honor of Edmund S. Phelps, Princeton: Princeton University Press, pp. 228-266.

[31] Laibson, David, Andrea Repetto, and Jeremy Tobacman. Forthcoming. "Estimating Discount Functions with Consumption Choices over the Lifecycle," *American Economic Review.*

[32] Laibson, David, and Leeat Yariv, "Safety in Markets: An Impossibility Theorem for Dutch Books," 2007. Working Paper, Caltech.

[33] McClure, Samuel M., Laibson, David, Loewenstein, George and Jonathan D. Cohen. 2004. "Separate Neural Systems Value Immediate and Delayed Monetary Rewards." *Science* (October):306.

[34] Millner, E. and Pratt, M. (1989). "An Experimental Investigation of Efficient Rent-Seeking." *Public Choice* 62(2):139-151.

[35] Mischel, W., Shoda Y., and Monica L. Rodriguez. 1989. "Delay of gratification in children." *Science* 244 (May): 933-38.

[36] Nti, K. 1999. "Rent Seeking with Asymmetric Valuations." *Public Choice* 98:415-430.

[37] Pink, Dan (2009) "Drive: The Surprising Truth About What Motivates Us" Riverhead Hardcover, 2009.

[38] Potters, J., de Vries, C., van Winden, F. (1998) "An experimental examination of rational rent-seeking," *European Journal of Political Economy*, 14, 783-800.

[39] Shefrin, H. M., and Richard Thaler. 1981, "An economic theory of self-control." *Journal of Political Economy*, 89(2), 392-406.

[40] Sheremeta, R.M. (2010a). "Contest Design: An Experimental Investigation," *Economic Inquiry*, forthcoming.

[41] Sheremeta, R.M. (2010b). "Multi-Stage Elimination Contests: An Experimental Investigation," *Games and Economic Behavior*, 68, 731-747.

[42] Shiv, B. and Fedorikhin, A. (1999). "Heart and mind in conflict: The interplay of affect and cognition in consumer decision making." *Journal of Consumer Research*, 26(2), 278-292.

[43] Smith, Vernon. (1982) "Microeconomic System as an Experimental Science." *American Economic Review*. 72(5), 923-955.

[44] Takeuchi, Kan. (2011). "Non-parametric test of time consistency: Present bias and future bias." *Games and Economic Behavior*, 71, 456-478.

[45] Thaler, Richard. "Some Empirical Evidence on Dynamic Inconsistency," *Economics Letters*, 1981, 8, 201 -207.

[46] Tullock, G., 1980. "Efficient rent seeking." In: Buchanan, J.M., Tollison, R.D., Tullock, G. (Eds.), Toward a Theory of the Rent Seeking Society. College Station: Texas A&M University Press, pp. 97-112

[47] Zizzo, D. 2010. "Experimenter Demand Effect in Economic Experiments," *Experimental Economics*, 13, 75-98.

5 Appendix

The instructions below are for the treatment in which both players would receive the prize during the class period in which they made their decisions. Bold font was used for emphasis with the subjects as to the timing of the prize. The other treatments were similar except for the discussion of the timing of when prizes were received. The page margins were set so that the direction fit a single page.

Experiment Instructions

This is an experiment in economic decision making. How much you earn will depend in part on what choices you make, so it is important that you understand these directions completely. If you have any questions, please raise your hand and a researcher will come to you. Except for questions asked to the experimenter, it is important that you do not talk or communicate with anyone else in this experiment.

You have been randomly matched with someone else in the experiment and each of you is being given \$5 to be paid to you at the end of class today and \$1 to be paid at the end of class in one week. Please legibly print your name on the outside of the envelope you received marked today's money and on the outside of the one marked next week's money.

Both you and the person you are matched with can use the \$5 you will receive **today** to bid on a \$5 prize. The chance the \$5 prize will go to you is proportional to the amount you bid relative to the amount the person you are matched with bids. Any amount you bid will be deducted from the \$5 you will receive **today**, regardless of whether or not you win the \$5 prize. Similarly, any amount the person you are matched with will be deducted from his or her **today's money**.

If you win the \$5 prize it will be added to your **next week's money** envelope. If the person you are matched with wins the \$5 prize then it will be added to his or her **next week's money** envelope.

To bid, you will simply write the amount you want to bid at the bottom of this form. Once you have determined your bid and written your name on your two white envelopes, you can put this sheet and the two envelopes back into the large brown envelope so the experimenters may collect it.

Let's look at a couple of examples.

Example: If you bid \$2.35 and the person you are matched with bids \$4.56 then the chance you will win the \$5 is 34% $\left(= \frac{2.35}{2.35+4.56}\right)$. This means that out of 100 trials you would expect to win the prize 34 times. Notice that you would not get back the \$2.35 you bid.

Example: If you bid \$0.87 and the person you are matched with bids \$0.29 then the chance you will win the \$5 is 75% $\left(= \frac{0.87}{0.87+0.29}\right)$. This means that out of 100 trials you would expect to win the prize 75 times. Notice that you would not get back the \$0.87 you bid.

After all of the bids have been collected, the experimenters will determine if you or the person you are matched with won the $5 and then distribute the payment you are due today in the envelope marked today's money. We will return in one week to make the payment you are due at that time in the envelope marked next week's money.

To summarize, your bid will be deducted from today's money and the prize (if you win) will be added to next week's money. The bid of the person you are matched with will be deducted from his or her today's money and the prize (if he or she wins) will be added to his or her next week's money.

By completing this form, I acknowledge that I have read the accompanying information regarding this study, am at least 18 years of age, and am voluntarily agreeing to participate in this study.

My bid is __________. This will be deducted from the $5 I will receive today.
Name ______________________________ Signature____
UA ID____________________ Total Payment (completed by researcher)_______________