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# Behavior in Contests

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## Abstract

Standard theoretical prediction is that rational economic agents participating in rent-seeking contests should engage in socially inefficient behavior by exerting costly efforts. Experimental studies find that the actual efforts of participants are significantly higher than predicted and that over-dissipation of rents (or overbidding or over-expenditure of resources) can occur. Although the standard theory cannot explain over-dissipation, this phenomenon can be explained by incorporating behavioral dimensions into the rent-seeking contest, such as (1) the utility of winning, (2) relative payoff maximization, (3) bounded rationality, and (4) judgmental biases. These explanations are not exhaustive, but they provide a coherent picture of important behavioral dimensions that should be considered when studying rent-seeking behavior in theory and in practice.

## 1. Introduction

Costly and unproductive competitions between economic agents are often portrayed as rent-seeking contests. Examples range from litigation and lobbying, to wars and violent global conflicts (Tullock, 1964; Krueger, 1974). The variety of economic and political situations that can be described as rent-seeking contests has attracted enormous attention from economic theorists. For a recent review of the theoretical literature see Konrad (2009).

The main idea of rent-seeking is very simple and it is used to describe socially inefficient but personally profitable behavior. People can engage in productive behavior (such as creating resources) and unproductive behavior (such as contesting for already existing resources). The unproductive behavior is known as rent seeking. The two most commonly used models to describe rent-seeking behavior are the rent-seeking contest model of Tullock (1980) and the all-pay auction (Dasgupta, 1986; Hillman and Riley, 1989). Both models assume that individuals exert costly irreversible efforts while competing for a prize. The individual probability of winning the prize depends on efforts exerted by all contestants. In the all-pay auction, the individual exerting the highest effort wins the prize with certainty. In the rent-seeking contest, the probability of winning the prize equals the ratio of an individual's effort to the sum of efforts exerted by all contestants. Both models provide many important theoretical results and comparative statics predictions. One of such theoretical results is that rational economic agents should always engage in unproductive behavior and that dissipation of rents is inevitable in equilibrium.

Theoretical models of rent-seeking have been extensively tested in controlled laboratory settings. For a comprehensive review of this literature see Dechenaux et al. (2014). Most laboratory studies find support for the comparative statics predictions of rent-seeking contests.

However, these studies also uncover a number of important behavioral phenomena which are not predicted by the theory. One of such phenomena is over-dissipation of rents (Sheremeta, 2013). This phenomenon is also known as overbidding or over-expenditures of resources, i.e., participants in laboratory experiments exert efforts which are significantly higher than predicted by the standard Nash equilibrium.

The standard rent-seeking contest model, based on the assumption of rational economic agents, cannot explain over-dissipation. Nevertheless, the over-dissipation phenomenon can be explained by incorporating behavioral dimensions into the standard model, such as (1) the utility of winning, (2) relative payoff maximization, (3) bounded rationality, and (4) judgmental biases. In this chapter, we discuss these behavioral dimensions of contests in detail. We restrict our attention mostly to rent-seeking contests of Tullock (1980), since such contests have attracted most attention from experimental researchers (Dechenaux et al., 2014) and the over-dissipation phenomenon has been extensively explored (Sheremeta, 2013).

We begin by introducing a standard theoretical contest model. Then, we provide a short overview of experimental literature on rent-seeking contests and discuss the over-dissipation phenomenon. Then, in order to explain over-dissipation, we extend the theory of contests to behavioral dimensions, such as the utility of winning, relative payoff maximization, bounded rationality, and judgmental biases. Finally, we conclude by suggesting directions for future research and discussing potential mechanisms that can reduce over-dissipation.


## 2. Standard Theoretical Contest Model

Perhaps the simplest model of rent-seeking is a lottery contest model proposed by Tullock (1980). In such a contest, there are $n$ identical risk-neutral individuals competing for a

prize value of $v$. The probability that individual $i$ wins the prize depends on individual $i$'s effort $e_i$ and the efforts of all other individuals. Specifically, individual $i$'s probability of winning the prize is defined by a contest success function (Skaperdas, 1996):

$$p_i(e_i, e_{-i}) = \frac{e_i}{\sum_{j=1}^{n} e_j}.$$ (1)

Given (1), the expected payoff for individual $i$ is equal to the expected benefit, i.e., the probability of winning the prize $p_i(e_i, e_{-i})$ times the prize value $v$, minus the cost of effort, i.e., $c(e_i) = e_i$. That is

$$\pi_i(e_i, e_{-i}) = p_i(e_i, e_{-i})v - e_i.$$ (2)

Differentiating (2) with respect to $e_i$ and accounting for the symmetric Nash equilibrium leads to an equilibrium effort:

$$e^* = \frac{(n-1)}{n^2} v.$$ (3)

There are no asymmetric equilibria in the lottery contest and the symmetric equilibrium (3) is unique (Szidarovszky and Okuguchi, 1997).[1] Therefore, each individual has an equal probability of winning in equilibrium, i.e., $p(e^*) = 1/n$. The equilibrium expected payoff can be calculated by plugging (3) into (2), which gives

$$\pi(e^*) = \frac{1}{n^2} v.$$ (4)

The dissipation rate, measured as a ratio of the total expenditures $ne^*$ to the value of the prize $v$, is

$$d(e^*) = \frac{(n-1)}{n}.$$ (5)

Economic intuition behind this model is straightforward. Higher value of prize $v$ implies higher equilibrium effort $e^*$, i.e., $\partial e^*/\partial v > 0$, and higher payoff $\pi(e^*)$, i.e. $\partial \pi(e^*)/\partial v > 0$. On

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[1] Multiple equilibria may arise if one formally introduces behavioral spillover (Chowdhury and Sheremeta, 2011a, 2011b, 2014) or risk preferences (Cornes and Hartley, 2012)

the other hand, higher number of competitors $n$ implies lower equilibrium effort $e^*$, i.e., $\partial e^*/\partial n < 0$ (due to so-called "discouragement effect"), and lower payoff $\pi(e^*)$, i.e., $\partial \pi(e^*)/\partial n < 0$.[2]

The classic formulation of a Tullock contest demonstrates the tension between the socially optimal and the individually rational behavior. The socially optimal level of effort is zero. In such a case, no effort is wasted, i.e., $e = 0$, and all individuals have equal probability of winning, i.e., $p(e) = 1/n$. The expected payoff is $\pi(e) = v/n$ and the dissipation rate is $d(e) = 0$. However, in equilibrium, the rational economic agent should engage in an unproductive competition by exerting costly efforts, i.e., $e^* = (n-1)v/n^2$, thus causing rent dissipation, i.e., $d(e^*) = (n-1)/n$. Each individual earns positive expected payoff, i.e., $\pi(e^*) = v/n^2$, and, as in the socially optimal case of no effort, all individuals have equal probability of winning, i.e., $p(e^*) = 1/n$.


## 3. Experimental Findings on Contests

Millner and Pratt (1989) were the first to examine a lottery contest using a laboratory experiment. In their experiment, participants were placed in groups of two, i.e., $n = 2$, and group composition changed from period to period. Each period, participants could submit their bids (efforts) in order to win a prize of $8, i.e., $v = 8$. Given these parameters, the unique equilibrium effort is $2, i.e., $e^* = v(n-1)/n^2 = 2$, the expected payoff is $2, i.e., $\pi(e^*) = v/n^2 = 2$, and the dissipation rate is 0.5, i.e., $d(e^*) = (n-1)/n = 0.5$. The results of the experiment showed

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[2] Theoretically, the "discouragement effect" arises because, when facing a stronger individual (or more individuals), a weaker individual cuts back on his costly expenditures (Baik, 1994; Gradstein, 1995; Stein, 2002). The "discouragement effect" has been well documented by numerous experimental studies (Fonseca, 2009; Anderson and Freeborn, 2010; Deck and Sheremeta, 2012; Kimbrough et al., 2014).

that the actual average effort of $2.24 and the dissipation rate of 0.56 are significantly higher than predicted. The magnitude of over-dissipation is about 12%.

**Figure 1: Distribution of Efforts.**
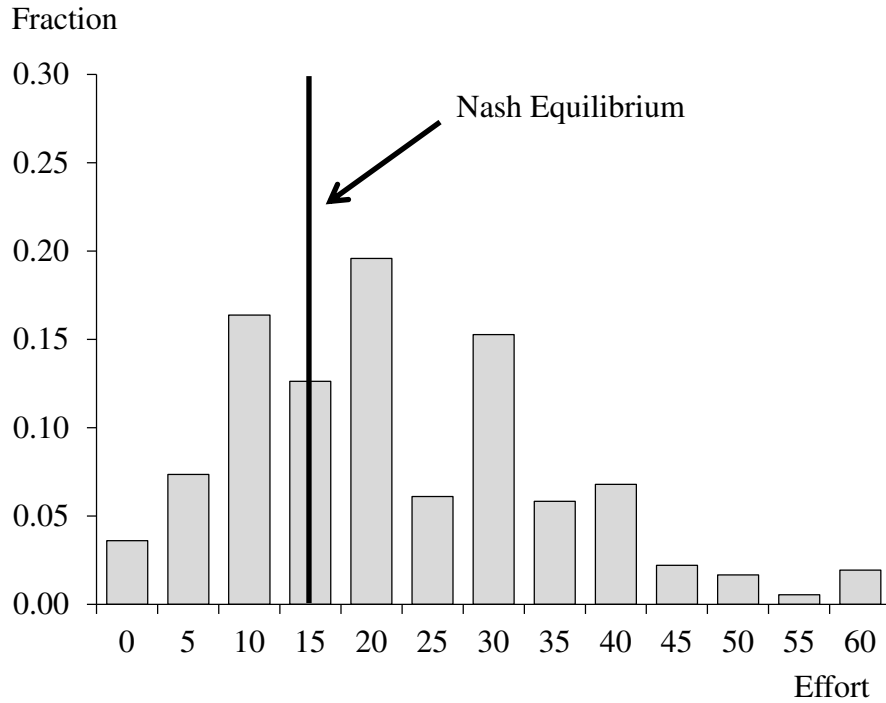


Note: The data are taken from Sheremeta (2011).

Since Millner and Pratt (1989), many other experiments have replicated the phenomenon of over-dissipation (Sheremeta, 2013; Dechenaux et al., 2014). Based on a sample of 30 contest experiments examined by Sheremeta (2013), the median over-dissipation rate is 72%. The magnitude of over-dissipation in some studies is so high that on average participants receive negative payoffs (Abbink et al., 2010; Sheremeta and Zhang, 2010; Price and Sheremeta, 2011, 2014; Morgan et al., 2012; Chowdhury et al., 2014; Lim et al., 2014; Mago et al., 2014). Figure 1 displays a typical distribution of effort in lottery contests. The data are taken from Sheremeta (2011), where $n = 2$ individuals compete for a prize of $v = 60$. According to the theoretical

prediction, the equilibrium effort is 15. Nevertheless, most participants exert efforts that are significantly higher than predicted, with an average over-dissipation of about 31%.

Why do participants over-dissipate relative to the standard Nash equilibrium prediction? In the next section, we extend the theory of contests to behavioral dimensions, such as the utility of winning, relative payoff maximization, bounded rationality, and judgmental biases in order to explain the phenomenon of over-dissipation.

## 4. Behavioral Dimensions of Contests

### 4.1. Utility of Winning

The standard theoretical contest model is based on the assumption that individuals care only about the monetary value of the prize, i.e., $v$. However, participants in actual contests also may care about winning itself. One way to incorporate the utility of winning into a contest model, is to assume that in addition to the prize value $v$, individuals also have an additive non-monetary utility of winning $w$ (Sheremeta, 2010). Therefore, the updated expected payoff of individual $i$ can be written as

$$\pi_i^w(e_i, e_{-i}) = p_i(e_i, e_{-i})(v + w) - e_i. \tag{6}$$

Differentiating (6) with respect to $e_i$ and accounting for the symmetric Nash equilibrium gives a new equilibrium effort, which is a function of both a monetary value $v$ and a non-monetary value $w$:

$$e_w^* = \frac{(n-1)}{n^2}(v + w). \tag{7}$$

The corresponding dissipation rate is

$$d(e_w^*) = \frac{(n-1)}{n}\frac{(v+w)}{v}. \tag{8}$$

It is easy to verify that the new equilibrium effort (7) increases in the non-monetary utility of winning $w$, i.e., $\partial e_w^*/\partial w > 0$. Moreover, for any $w > 0$, the dissipation rate $d(e_w^*)$ described by (8) is higher than the standard dissipation rate $d(e^*)$ described by (5). Therefore, if in addition to the prize value $v$, individuals indeed have the non-monetary utility of winning $w$, we should observe over-dissipation in rent-seeking contests.

Although the utility of winning is an appealing behavioral explanation for the over-dissipation phenomenon, it is not trivial to test whether economic agents indeed have such a utility. Sheremeta (2010) designed a method to elicit the utility of winning by having individuals participate in the contest with a monetary prize and then in the contest with no prize. The results of the experiment showed that individuals who exert significant efforts just to be recognized as winners also behave overly competitive in the contest with the monetary prize. In the experiment, students participated in 30 periods of play in a four-individual contest, i.e., $n = 4$, with a prize value of 120, i.e., $v = 120$. At the end of the experiment, participants were asked to submit their efforts for a prize value of 0, i.e., $v = 0$. Participants were explicitly told that they would have to pay for their efforts and that they would not receive any monetary benefit in case they won. If participants value only monetary payoffs, they should not exert any effort when the monetary prize value is zero. However, if participants derive utility from winning, they may choose to exert positive efforts even when there is no monetary prize.

Sheremeta (2010) found that more than 40% of economically motivated participants exert positive efforts in the contest with a prize value of zero. Moreover, efforts in a contest with a zero prize are correlated with efforts in contests with a strictly positive prize. Figure 2 displays the correlation between an effort for a prize of $v = 0$ and an average (over 30 periods of play) effort for a prize of $v = 120$. According to the theoretical prediction (3), the equilibrium effort is

22.5 when the prize is 120 and 0 when the prize is 0. Figure 2 shows that there is substantial heterogeneity in efforts, and participants who exert higher efforts for the prize of 0 also exert higher efforts for the prize of 120 (Spearman's correlation coefficient is 0.31, p-value < 0.01). Therefore, it appears that in addition to monetary utility, many participants derive non-monetary utility of winning and such a utility can partially explain over-dissipation in rent-seeking contests.

**Figure 2: Utility of Winning.**
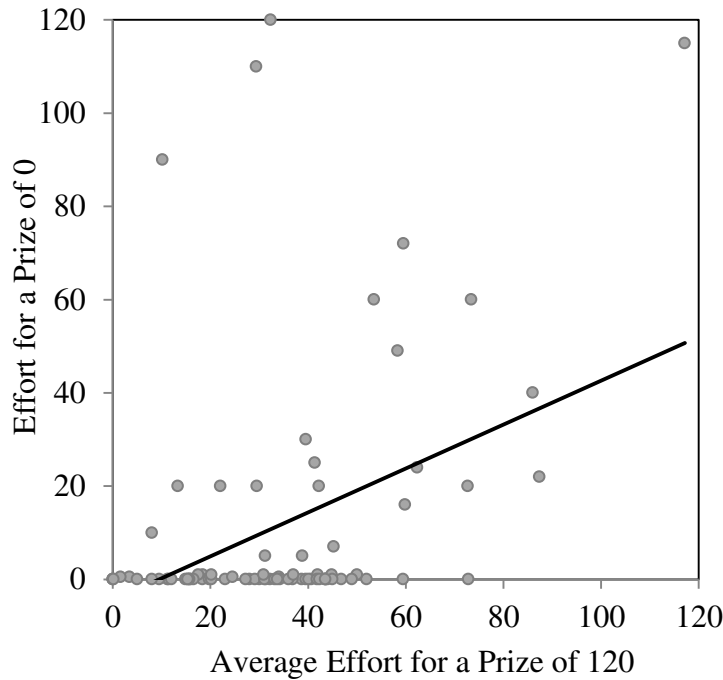


Note: The data are taken from Sheremeta (2010).

The findings of Sheremeta (2010) have been replicated by other studies (Price and Sheremeta, 2011, 2014; Cason et al., 2013; Brookins and Ryvkin, 2014; Mago et al., 2014). This suggests that the utility of winning is a robust behavioral regularity that should be incorporated into theoretical models of rent-seeking. However, the exact specification of the utility of winning is still an open question. For example, it is possible that the utility of winning is not additive and is not invariant to the value of the monetary prize $v$, in which case, the correct specification of

the utility of winning would be $w = w(v)$. It is also possible that the utility of winning may depend on the number of contestants $n$, in which case, the correct specification of the utility of winning would be $w = w(n)$. Disregarding the exact functional form, the utility of winning is an important behavioral factor which can help explaining over-dissipation.

## 4.2. Relative Payoff Maximization

Related to the utility of winning, studies show that over-dissipation may be driven by spiteful preferences and relative payoff maximization (Fonseca, 2009; Cason et al., 2013; Eisenkopf and Teyssier, 2013; Mago et al., 2014). Mago et al. (2014) propose a theoretical model in which individuals care not only about the utility of winning $w$ but also about the weighted average payoff of other group members. In such a case, the expected utility of individual $i$ can be written as

$$U_i(e_i, e_{-i}) = \pi_i^w(e_i, e_{-i}) + s\frac{1}{n}\sum_j \pi_j^w(e_j, e_{-j}),\tag{9}$$

where $s$ is a relative payoff parameter representing a measure of how individuals weight their payoffs relative to others: $s > 0$ reflects preferences of pro-social individuals seeking to increase the payoff of others, while $s < 0$ reflects preferences of status-seeking individuals striving to obtain a higher relative payoff than others. The exact origin of the relative payoff plarameter $s$ is ambiguous. First, it may be the case that individuals simply have other-regarding preferences (Fehr and Schmidt, 1999). Second, evolutionary game theory would argue that individuals care about their "survival" payoff (Leininger, 2003; Hehenkamp et al., 2004; Riechmann, 2007). Finally, the quest to seek higher expected payoff than others is also consistent with the 'spite effect' (Hamilton, 1970). Despite the origin of the relative payoff maximization, there is

substantial amount of research indicating that individuals care about their payoff relative to others in the group (Frey and Stutzer, 2002)

Differentiating (9) with respect to $e_i$ and accounting for the symmetric Nash equilibrium gives the equilibrium effort

$$e_{ws}^* = \frac{(n-1)}{n(n-s)}(v+w). \tag{10}$$

The corresponding dissipation rate is

$$d(e_{ws}^*) = \frac{(n-1)}{(n-s)}\frac{(v+w)}{v}. \tag{11}$$

It is easy to verify that the equilibrium effort (10) increases in the utility of winning $w$, i.e., $\partial e_{ws}^*/\partial w > 0$, and increases in the relative payoff parameter $s$, i.e., $\partial e_{ws}^*/\partial s > 0$. Moreover, for $w > 0$ and $s > 0$, the dissipation rate $d(e_{ws}^*)$ described by (11) is higher than the standard dissipation rate $d(e^*)$ described by (5).

In their experiment, Mago et al. (2014) find that 51% of participants indicate positive utility of winning, i.e., $w > 0$, replicating the findings of Sheremeta (2010). Moreover, Mago et al. find that 67% of participants behave as status-seekers, i.e., $s > 0$. These findings suggest that over-dissipation in contests can be explained by a combination of a utility of winning and relative payoff maximization.


## 4.3. Bounded Rationality

The two explanations that we have discussed so far are based on the behavioral facts that individuals participating in contests care about winning itself ($w$) and their relative payoffs ($s$). Another well document behavioral fact is that people are prone to mistakes and instead of behaving rationally, people use bounded rationality (Camerer, 2003).

One way to introduce bounded rationality into a contest model is to assume that participants make mistakes, which add noise to the Nash equilibrium solution. McKelvey and Palfrey (1995) suggested an elegant method of incorporating mistakes into strategic environments, naming the corresponding solution a quantal response equilibrium (QRE). In the Nash equilibrium (3), each individual plays a pure strategy $e^*$, given that others are playing the equilibrium strategy $e^*$. In the QRE, each individual plays a mixed strategy $\sigma^*$ in which the probability of playing a pure strategy $e$ is increasing in the expected payoff $\pi(e, \sigma^*)$ of that strategy, given that others are playing the equilibrium mixed strategy $\sigma^*$. The most commonly used specification of the QRE is the logistic QRE, where the equilibrium probability of choosing $e$ is given by:

$$\sigma^*(e) = \frac{\exp(\pi(e,\sigma^*)/\mu)}{\int_x \exp(\pi(x,\sigma^*)/\mu)}, \tag{12}$$

where $\mu > 0$ is an error parameter describing the level of noise in the decision making process. If $\mu \to 0$, then the Nash equilibrium effort $e^*$ is chosen with probability one, i.e., $\sigma^*(e^*) = 1$. If $\mu \to \infty$, then each effort $e$ between 0 and the maximum allowed effort level is equally likely to be chosen.

One implication of the QRE is that if individuals are unconstrained and are allowed to exert any effort between 0 and the value of the prize $v$, then any level of mistakes, i.e., $\mu > 0$, will lead to over-dissipation (Sheremeta, 2011; Chowdhury et al., 2014; Lim et al., 2014). The intuition is simple. Consider an individual who is completely confused and does not understand the rules of the game, i.e., $\mu \to \infty$. According to the QRE, such an individual will make his decision by randomly choosing any effort level $e$ between 0 and the value of the prize $v$. Therefore, such an individual on average will exert an effort of $v/2$, which is higher than the Nash equilibrium effort $e^* = v(n-1)/n^2$, for any $n \geq 2$.

**Figure 3: Expected Average Effort at the QRE.**
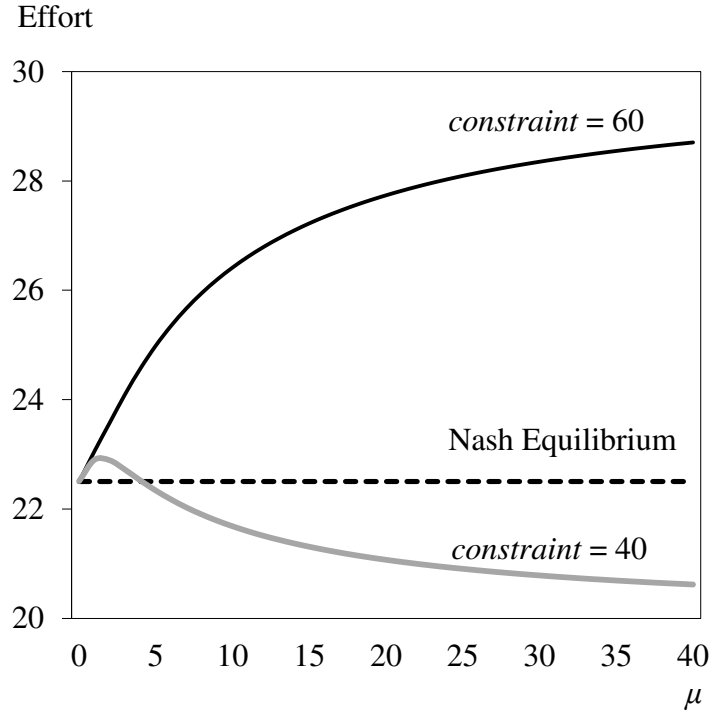


Sheremeta (2011) explicitly tests the predictions of the QRE model by conducting two experimental treatments. In each treatment, four participants, i.e., $n = 4$, compete in a lottery contest for a prize value of $v = 120$. In one treatment, participants are constrained to choose their efforts between 0 and 60 and in the other treatment participants are constrained to choose their efforts between 0 and 40. Constraining participants to choose their efforts not higher than either 60 or 40 is not binding relative to the Nash equilibrium of 22.5, i.e., $e^* = v(n-1)/n^2 = 22.5$. Figure 3 displays the expected average effort at the QRE as a function of $\mu$ and *constraint*. When $\mu \to 0$, the behavior is consistent with the Nash equilibrium. When $\mu \to \infty$, individuals move closer to a random play, and thus the average effort approaches 30 (over-dissipation) for the constraint of 60 and it approaches 20 (under-dissipation) for the constraint of 40. Therefore, if participants make substantial level of mistakes, then the average effort should be significantly higher in the treatment with the constraint of 60. Sheremeta (2011) finds that the actual average

effort is 29.3 when the constraint is 60 and it is 21.0 when the constraint is 40, consistent with the predictions of the QRE.

The findings of Sheremeta (2011) suggest that participants indeed make mistakes when participating in rent-seeking contests and such mistakes can explain over-dissipation. There are two potential explanations as to why participants make mistakes. First, it is possible that participants hold incorrect beliefs about the actions chosen by their opponents. Second, participants may simply make errors in their own actions. The first explanation is less likely to be true. The main reason is that the best-response functions in lottery contests are structured in such a way that if a participant believes that the opponent is going to either make higher or lower than the equilibrium effort, his best response is to always exert lower than the equilibrium effort.

## 4.4. Judgmental Biases

It is well documented in behavioral economics literature that people not only make random mistakes (as in the case of the QRE), but they also exhibit systematic "judgmental biases" (Camerer et al., 2011) which can explain behavior in rent-seeking contests (Baharad and Nitzan, 2008; Sheremeta and Zhang, 2010; Chowdhury et al., 2013, 2014; Price and Sheremeta, 2014).

Baharad and Nitzan (2008) apply an idea of distorted probability weighting function from "prospect theory" of Kahneman and Tversky (1979) to prove that over-dissipation of rents is theoretically possible. Following Tversky and Kahneman (1992), they assume that individuals assign a distorted (biased) inverse S-shaped probability weighting function $b(p)$ to the objective probability $p$. Thus, instead of contest success function (1), individual's perceived probability of winning is given by

$$b(p) = \frac{p^\beta}{(p^\beta + (1-p)^\beta)^{1/\beta}}. \tag{13}$$

Given the distortion function (13), the expected payoff for an individual $i$ can be written as

$$\pi_i^d(e_i, e_{-i}) = b(p_i(e_i, e_{-i}))v - e_i. \tag{14}$$

Differentiating (14) with respect to $e_i$ and accounting for the symmetric Nash equilibrium gives the equilibrium effort

$$e_b^* = \frac{(n-1)}{n^\beta(1+(n-1)^\beta)^{1/\beta}}\left(\beta - \frac{1-(n-1)^{\beta-1}}{1+(n-1)^\beta}\right)v. \tag{15}$$

The corresponding dissipation rate is

$$d(e_b^*) = \frac{n(n-1)}{n^\beta(1+(n-1)^\beta)^{1/\beta}}\left(\beta - \frac{1-(n-1)^{\beta-1}}{1+(n-1)^\beta}\right). \tag{16}$$

When comparing the dissipation rate $d(e_d^*)$ described by (16) to the standard dissipation rate $d(e^*)$ described by (5), we find that for certain configurations of parameters it is possible to observe over-dissipation, i.e., $d(e_b^*) > d(e^*)$. For example, with $n = 15$ and $\beta = 0.61$, the dissipation rate described by (16) is $d(e_b^*) = 1.05$, while the standard dissipation rate described by (5) is $d(e^*) = 0.9$. The magnitude of over-dissipation is about 16%, which is close to the magnitude of over-dissipation observed in many experimental studies (Sheremeta, 2013; Dechenaux et al., 2014).

Although there is substantial evidence for the distorted probability weighting function both in the laboratory and in the field (Wu and Gonzalez, 1996; Bruhin et al., 2010), there are currently no experimental studies directly relating the phenomenon of over-dissipation to the distorted probability weighting.[3] Closely related studies have examined how the behavior of participants in rent-seeking contests changes when the contest success function (1) is replaced by

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[3] Parco et al. (2005) and Amaldoss and Rapoport (2009) apply the distorted probability weighting function, combined with a utility of winning, to explain the pattern of the data observed in their contest experiments. However, in their experiments participants are budget constrained, making it impossible to observe over-dissipation.

a share function (Cason et al., 2010, 2013; Fallucchi et al., 2013; Shupp et al., 2013; Chowdhury et al., 2014). Chowdhury et al. (2014), for example, design a two-by-two experiment, by varying whether the prize is assigned probabilistically (i.e., efforts determine the probabilities of winning the prize) or proportionally (i.e., efforts determine the shares of the prize) and whether the cost function is linear or convex. Although in all treatments the risk-neutral Nash equilibrium effort level is constant, Chowdhury et al. find that compared to the probabilistic contest success function, the proportional rule results in effort levels that are closer to the risk-neutral prediction (with almost no over-dissipation).[4] Combining the proportional rule with a convex cost function further strengthens these results. Therefore, it appears that even though there is no direct evidence as to whether distorted probability weighting causes over-dissipation in rent-seeking contests, related studies show that even a slight modification to the contest success function plays a major role in determining individual behavior.

Price and Sheremeta (2014) apply another idea from prospect theory of Kahneman and Tversky (1979) to explain over-dissipation in contest experiments. They design an experiment in which some participants have to earn their income before participating in a laboratory rent-seeking contest experiment. Price and Sheremeta find that participants who earn their income exert lower efforts in subsequent contests than participants who receive their income directly from the experimenter. The main reason for this result is that participants who earn their income and participants who receive their income for free have difference reference points. Participants who earn their income operate in the domain of losses, while participants who receive free income operate in the domain of gains.

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[4] Note that the proportional rule eliminates the utility of winning and thus lover over-dissipation also might be due to the absence of the utility of winning,

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Sheremeta and Zhang (2010) and Chowdhury et al. (2013) discuss yet another judgmental bias that may partially explain over-dissipation in repeated contests. Specifically, they find that, participants who win in period $t$-1 are more likely to make higher efforts in period $t$. Sheremeta and Zhang (2010) point out the similarities of correlation between winning in period $t$-1 and higher efforts in period $t$ to a "hot hand" phenomenon found in the gambling literature – belief in a positive autocorrelation of a non-autocorrelated random sequence (Gilovich et al., 1985; Chau and Phillips, 1995; Croson and Sundali, 2005). Therefore, it appears that hot hand response by participants may help explaining over-dissipation in repeated contest settings.[5]

## 5. Discussion and Conclusion

Many economic and political environments can be characterized as rent-seeking contests in which economic agents choose to engage in unproductive competition in order to obtain a scarce resource. Such rent-seeking contests have been extensively studied by economic theorists (Konrad, 2009). In recent years, theoretical rent-seeking models have been extensively tested in controlled laboratory settings (Dechenaux et al., 2014). One of the main findings from these studies is that participants exert efforts which are significantly higher than predicted by the standard Nash equilibrium (Sheremeta, 2013). This phenomena is commonly referred to as over-dissipation of rents, overbidding, or over-expenditure of resources.

The standard rent-seeking contest model, based on the assumption of rational economic agents, cannot explain over-dissipation. Nevertheless, the over-dissipation phenomenon can be explained by incorporating behavioral dimensions into a standard contest model, such as (1) the utility of winning, (2) relative payoff maximization, (3) bounded rationality, and (4) judgmental

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[5] Most experimental studies use repeated designs in order to give participants enough time for learning.

biases. Although these explanations are not exhaustive, they provide a coherent picture of important behavioral dimensions that should be considered when studying rent-seeking behavior in theory and in practice.[6]

There are several fruitful avenues for future research. First, it is still an open question as to what behavioral dimensions are the most important in explaining individual behavior in rent-seeking contests. For example, it is possible that some of the factors explaining over-dissipation are correlated, e.g., the relative payoff maximization may be driven by the utility of winning, or judgmental biases may be driven by systematic mistakes. The relative impact of these factors on individual behavior remains unknown.

Second, given the prevalence of over-dissipation in laboratory experiments it is important to know whether over-dissipation occurs in field settings with real-effort and high stakes. Do field experiments offer insights on whether over-dissipation is a robust phenomenon? If so, then are the explanations for over-dissipation in the field similar to the explanations for over-dissipation in the laboratory? These questions are very important and answering them would significantly advance our understanding of over-dissipation phenomenon.

Finally, given that rent-seeking behavior is unproductive and very costly (even more so than predicted by the theory), it is important to develop and investigate mechanisms aimed at avoiding unproductive competitions.[7] Since the seminal book by Schelling (1960), a number of mechanisms for avoiding conflicts have been proposed, ranging from deterrence via extensive

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[6] One may add to this list other candidates such as regret, overconfidence, and risk aversion. It is important to emphasize, however, that risk aversion cannot explain over-dissipation in contests (Dechenaux et al., 2014). Although theoretically it is possible for risk aversion to cause over-dissipation (Treichm, 2010; Cornes and Hartley, 2012), experimental contest studies show that more risk-averse subjects choose lower efforts than less risk-averse subjects (Millner and Pratt, 1991; Anderson and Freeborn, 2010; Sheremeta and Zhang, 2010; Sheremeta, 2011; Mago et al., 2013; Shupp et al., 2013).

[7] Over-dissipation is not desirable, since in the context of rent-seeking a welfare maximizing social-planner seeks to minimize socially wasteful expenditures. However, in the context of R&D and labor tournaments, a social planner may desire the positive externalities generated from increased research spending (Cason et al., 2010).

armament to contractually binding side-payments. Recent experimental studies have examined different conflict resolution mechanisms including side-payments (Kimbrough and Sheremeta, 2013, 2014), random devices (Kimbrough et al., 2013, 2014), communication (Cason et al., 2012, 2014), cooperative spillovers (Savikhin and Sheremeta, 2013), and social identification (Mago et al., 2014). Whether these mechanisms are effective in the field remains an open question.

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