Heterogeneity and Selection in Contests

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Erklärung zu Koautoren

Die vorliegende Dissertation umfasst neben einer Einleitung (Kapitel 1) vier Forschungspapiere (Kapitel 2 bis 5) und ein Fazit (Kapitel 6). Die Kapitel 1, 4, 5 und 6 sind allein verfasst worden. Die Kapitel 2 und 3 sind in Ko-Autorenschaft entstanden. Ko-Autoren der Kapitel 2 und 3 sind Prof. Dr. Florian Morath und Prof. Dr. Kai A. Konrad. Für die Dissertation sind diese Kapitel gegenüber den gemeinsam verfassten Artikeln redaktionell leicht angepasst worden. Diese Veränderungen verantwortet allein die Autorin der vorliegenden Dissertation.

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Chapter 1

Introduction

1.1 Motivation

Tullock's (1980) analysis of rent-seeking behavior has become one of the most commonly used analytical frameworks in economic research on contests.[1] In any contest, there is a number of players who compete for a rent mostly of a given size (often called the prize). Players strive to receive a large share of this rent or secure a larger probability of receiving the whole rent. In order to increase their share or their probability of winning, they expend costly effort. These efforts are sunk, irrespective of how successful the players are in attracting the rent. A player's effort increases his (expected) share in the rent, and, at the same time, reduces the (expected) share of the rent that other players can receive. The other players may also expend such non-refundable effort. Hence, a contest solves a distributional problem in a very inefficient manner because a lot of effort is expended and wasted from a collective point of view.

Irrespective of contests being potentially wasteful, instances of players solving a distributional problem in this manner can be found in economic, but also political and social environments. In any such situation, the players try to get ahead of their rivals by expending scarce resources. The type of resource they expend varies depending on the specific example. It can

[1]There exist several microfoundations (see, e.g., Hirshleifer and Riley 1992, Fullerton and McAfee 1999, and Baye and Hoppe 2003) and axiomatic foundations (see Skaperdas 1996 and Clark and Riis 1998) for this type of contest structure.

be money, effort, soldiers, guns, time, or any other scarce resource. Conflictual situations that can be modelled as contests include advertising (e.g., Schmalensee 1972 and 1978), political campaigns (e.g., Baron 1994, Skaperdas and Grofman 1995), litigation (e.g., Hirshleifer and Osborne 2001, Baye et al. 2005, Robson and Skaperdas 2008), patent races (e.g., Reinganum 1989, Baye and Hoppe 2003), sports competitions (e.g., Szymanski 2003, Runkel 2011), promotion tournaments (e.g., Lazear and Rosen 1981, Rosen 1986, Müller and Wärneryd 2001, Tsoulouhas et al. 2007), sales contests (e.g., Lim et al. 2009, Chen et al 2011), lobbying (e.g., Nitzan 1994, Epstein and Nitzan 2004, Polborn and Sahakyan 2007), mating contests (especially in biology, e.g., Parker 1974, for surveys see Andersson 1994, and Hardy and Briffa 2013) or military combat and war (see Konrad 2009 for a more thorough description of these examples).

Due to the large variety of possible applications, there is a large and growing theoretical literature on contests (see Konrad 2009 for a survey). Obviously, researchers would also like to test their theories and address the issues surrounding contests using data. However, individual effort is difficult to observe in the field, since only the joint outcome of effort, ability and noise (the performance of the contestant) can be observed. Moreover, there are issues of self-selection and a lot of unobservables that make an empirical analysis with observational data difficult. Therefore, data from experimental contests is the preferred choice. The beauty of controlled experiments lies in allowing to clearly test theories and channels without confounding effects. In the laboratory, effort choices are often monetarized and thus easy to measure. Moreover, it is possible to induce differences between the contestants for example in terms of strengths. Furthermore, by comparing different treatments whose designs differ in nothing but one aspect, it is possible to directly attribute changes in human behavior to changes in the treatment. The first studies to test contest theory in the laboratory were conducted by Bull et al. (1987) and Millner and Pratt (1989, 1991). Since then, a large body of papers on experimental contests has been published. When Dechenaux et al. (2015) surveyed the literature on experimental contests (including all-pay auctions and rank-order tournaments) they already found more than 200 experimental papers on the topic.

Despite the work that has been carried out, a few puzzles related to conflict and (experimental) contests remain. I will name three puzzles which this thesis addresses below. One very basic puzzle is why resource wasteful conflict emerges at all. Often, the participants of a contest would all be better off if they split the rent peacefully rather than engaging in costly conflict. This is especially true for a military conflict in which peace would save lives, but also in other situations. In the corporate world, companies could save on costs for lawyers if disputes could be settled without lawsuits. For example, patent litigation burns millions of dollars of the private and public hand (for estimations see, e.g., Choi 2005 and Harhoff 2009). Another example are the primaries in the US presidential elections (Klumpp and Polborn 2006). In their campaigns, the candidates spend unbelievable amounts of money to convince the electorate that they should be their party's presidential nominee.[2] Additionally, US tax payers bear a large burden of these elections.[3] With this in mind, the obvious question is why people prefer to expend so many resources (often in vain). Can we say something about the circumstances that facilitate or hinder the outbreak of a violent conflict?

Another puzzle concerns alliance formation in contests. From a rational choice perspective, alliances in a contest suffer from two disadvantages. First, the members of the alliance face a free-rider problem, as the effort they expend is a contribution to a public good (Olson and Zeckhauser 1966). All members benefit from higher collective effort of the alliance, but each individual member prefers additional effort to be expended by the other members of the alliance. Second, the members of the alliance face a hold-up problem: If they win the contest, they have to decide on how to divide the prize. If they allocate the prize by means of another costly conflict, the effort expended in this internal distributional conflict reduces the value they attribute to winning the prize. This further discourages the members

[2] For example, in the 2012 primaries Mitt Romney spent almost $80 million (see http://theweek.com/articles/476099/cost-mitt-romneys-nomination-by-numbers). The cost of only launching a campaign in 2016 was estimated by Fortune magazine to be more than $50 million (see http://fortune.com/2015/03/28/campaign-financing/). Also compare http://www.huffingtonpost.com/gobankingrates/2016-election-results-vs_b_9369246.html for actual spendings in the current 2016 primaries.

[3] The cost of the 2012 primaries to the public was estimated to be $400 million (see http://ivn.us/2013/03/25/partisan-primaries-cost-taxpayers-400-million-last-year).

of an alliance when they decide on the effort they expend in the (external) conflict.[4] In other words, expending one unit of effort is less valuable for an alliance member than for an individual (stand-alone) contestant. Why, then, do we see alliances being formed in wars, coalitions being built for governments, strategic alliances being formed by firms, teamwork on the rise in companies? Is William Tell right that "the strong man is the strongest when alone," as he claims when he refuses to join the alliance in Friedrich Schiller's (1804) saga of the Rütli oath? Is Stauffacher right that "even the weak grow strong by union," in the same drama? Can we identify advantages of alliance formation that have been overlooked traditionally? Can we learn something about who is more likely to form an alliance?

Third, not only do (some) people like to fight a contest and (some) people do enjoy being part of a group in a contest despite the obvious disadvantages, but we also see that once they are in a violent conflict, contestants typically overexert effort (Sheremeta 2013, 2016). They spend more than what the Nash equilibrium with payoff maximizing agents would predict. This is the last puzzle we look at in this thesis. A number of explanations such as bounded rationality, mistakes, probability distortions, inequality aversion, spite or impulsive behavior have been put forward to explain it. We concentrate on another popular explanation for the higher effort: the joy of winning. How large is the joy of winning? If we add a non-monetary component of winning or losing a contest on top of the monetary prize, can we say something about the implications for effort?

All of the above puzzles and the resulting questions allude to issues of heterogeneity and selection. Below, I will describe the particular type of heterogeneity and selection in more detail.

1.1.1 Heterogeneity

Usually, early economic models work with the assumption of homogeneous players. However, "variety is the spice of life" according to a proverbial saying. Translated into economics, this means that introducing heterogeneity of players into economic models can yield new and sometimes surprising

[4] The experimental evidence by Ke et al. (2013) confirms such a hold-up effect.

insights. This is also true for contest theory. An established result is that an increase in player heterogeneity leads to a decrease in aggregate effort (Baye et al. 1993, Gradstein 1995, Stein 2002).

Players can be heterogeneous in their abilities, fighting strengths or cost of effort, but also in their valuations of the prize. For instance, the marginal value of securing a patent may be smaller for an established pharmaceutical company than for a start-up, and the value of winning a championship may be higher for one professional athlete than for another (for example, because an attractive sportsman can make more money from sponsoring and advertising than a sportsman of average appearance). These are examples of heterogeneous prize values in patent races and sports tournaments. There are also examples of heterogeneous abilities, cost of effort or fighting strengths in political competition, promotion tournaments and military conflict. In political competition, it might be less costly for a rich or well-connected candidate to finance an expensive election campaign than for a poor newbie. Further, men might be more able to work extra hours in the office in the evening than women, trying to convince the boss of being the right candidate for a promotion. Finally, the fighting strengths of soldiers of the Russian army might be different from the fighting strengths of combatants of the so-called Islamic State.

In this thesis, we make an effort to control for observed heterogeneity for example in risk attitudes among the experiment participants in the best possible way, using laboratory and econometric methods. However, we also induce heterogeneity in terms of differences in cost of effort in chapters 2 and 3. These differences represent differences in ability, fighting strength, or motivation. Moreover, in chapters 2, 4, and 5 we try to capture heterogeneity in terms of differences in the value of the prize. These differences can stem from a non-monetary valuation of winning. In chapter 2, players differ in intrinsic and extrinsic motivation and we are interested in whether stronger types (with a high motivation) or weaker types (with a low motivation) are more likely to decide to fight in an alliance rather than as a stand-alone player. In chapter 3, players differ in extrinsic motivation and in unobserved intrinsic motivation. We are interested in whether strong types (with a low cost of effort) or weak types (with a high cost of effort) decide to fight a contest or find a peaceful solution to dividing the prize and how an increase in the heterogeneity of their extrinsic motivation affects this decision. In chapters 4 and 5, players differ only in intrinsic motivation. We analyze how much money players are willing to pay in order to fight a contest again and use this number to measure the player's heterogeneity in intrinsic motivation in chapter 4. In chapter 5, we analyze how heterogeneity in intrinsic motivation affects selection decisions and effort in the contest.

1.1.2 Selection

Selection is an important topic in economics. Depending on the area, it has different connotations. While a micro theorist might think of adverse selection (Akerlof 1970), an econometrician might think of the sample selection bias (Heckman 1979). In contests, selection can be on the type of payment, e.g., the decision for a tournament vs. piece-rate payment or a winner-takes-it-all vs. a proportional prize contest. It can also be on whether or not to enter a contest, e.g., whether to enter a highly competitive job market for professional dancers or scientists. Relatedly, there is the decision on whether to become active in a contest, e.g., architects are always in a contest to win projects, but sometimes an architect might decide against even submitting a draft in a competition if there is a favored experienced competitor. Theory has also analyzed the factors determining whether to become active in a contest and their interaction with heterogeneity of the players (see e.g., Stein 2002) showing that the players with a low valuation of the prize or large effort costs may want to abstain from the conflict.

In this thesis, the number of active contestants in a given contest is always fixed. In chapters 3, 4 and 5 we consider two-player contests. Chapter 3 is about the (indirect) selection of entering into a contest or peacefully dividing a rent. Chapters 4 and 5 deal with the selection to play a contest again or to stay with the outcome of a previously played contest. Hence, this question is related to choosing a particular form of payment. Chapter 2 analyzes the decision to select into an alliance or fight as a stand-alone player in a three-player contest, i.e., the decision is about selecting the type of contest. The advantage of analyzing these questions in the laboratory is that we observe all selection decisions, circumventing the problem of a bias introduced by unobserved self-selection.

Selection into groups is interesting because many contests are characterized by competition between groups (or "teams" or "alliances") and not individuals. Examples include competition between corporate consortia, R&D competition between firms, election campaigns by political parties, and alliances between countries engaged in warfare, such as the Allied Powers of the Second World War. The formation and performance of alliances in conflicts is a topic as old as the study of conflict and much of the recent modeling in this area has employed contest theory (for a survey, see Bloch 2012). In parallel, the interest in experiments on group and alliance behavior in contests has grown. In group contests, members of the same group have an incentive to cooperate with each other by contributing individual efforts in order to win the contest. Since effort is costly, each member also has an incentive to shirk in contributing effort and free-ride on the efforts of other members. Hence, we also touch upon the issue of adverse selection because players with a low motivation are more likely to decide for joining an alliance.

One of the disadvantages of alliance formation is the hold-up problem, as mentioned above. If the alliance wins the contest, the alliance members have to decide about how to divide the prize (for example think about the discussion about how to divide Germany at the Yalta Conference). If the alliance members cannot agree on a peaceful division, they allocate the prize by means of another costly conflict.[5] Whether there is conflict or peace is a fundamental question, not only for victorious alliances. The determinants of the outbreak (or the end) of violent conflict have been studied both theoretically and empirically in economic theory, political science, international relations and political economy. Military conflict is the first application that comes to mind (e.g., if two countries negotiate about dividing resources such as oil or fishing waters, but negotiations break down, they go to war). However, we can also see the outbreak of wasteful conflict in other applications such as elections or litigation (e.g., if two parties want to form a coalition,

[5] This is the focus of the paper by Ke et al. (2015). The experimental evidence shows that the imbalance between alliance members' fighting strengths matters for the likelihood of internal conflict.

but cannot agree on their positions, they use uncoordinated policy platforms in their election campaigns or if two firms negotiate about the extent of a patent, but fail to reach an agreement, they go to court).[6] This type of selection into open conflict is studied in chapter 3, with a focus on the interaction of the balance or imbalance of power, strategic uncertainty and the existence of a mediator.

In experimental lottery contests we typically observe that players in the laboratory expend more than what the Nash equilibrium predicts. One of the explanations for it is that winning a contest yields a non-monetary joy of winning. Chapter 4 uses a special bidding mechanism that leads to self-selection of players, with the aim of backing out the extent of this joy of winning. Finally, chapter 5 analyzes the consequences of self-selection according to the joy of winning on aggregate effort.

1.2 Contribution and main results

In this thesis, I use theory-guided controlled laboratory experiments to answer a number of research questions. The research questions in the following chapters fit different types of applications particularly well. Nevertheless, I concentrate on winner-take-all Tullock lottery contests with linear costs throughout. Below, I will give a short outline of the contribution and a preview of the main results of the following chapters.

1.2.1 Endogenous group formation

This chapter focusses on the self-selection of certain types of players into alliances. We experimentally study endogenous alliance formation and contest effort choices in a generic three-player contest. Endogenous alliance formation may strengthen positive aspects such as in-group favoritism and in-group solidarity compared to exogenously formed alliances. However, adverse selection can constitute a major problem when alliances are formed on a voluntary basis. We ask: Under which circumstances do players prefer to join an alliance and which type of players prefers to form an alliance (and

[6] The three examples are borrowed from Bester and Wärneryd (2006).

vice versa, what are the characteristics of a player who prefers to fight as a stand-alone player)?

Taking into account that individuals may differ in their intrinsic or extrinsic incentives to expend effort, the theory analysis predicts that such heterogeneity leads to a self-selection of weakly motivated players into alliances while strongly motivated players prefer to stand alone in an upcoming conflict. The intuitive reason is that strong players bear a disproportionately high share of the cost of alliance effort and therefore prefer to stand alone while weak players benefit from the free-riding opportunities inside alliances.

The experimental evidence on self-selection is in conformity with the theory analysis of the game. In particular, the experimental results show that self-selection occurs along heterogeneity in both intrinsic and extrinsic motivations. So-called strong players who have a low monetary and/or non-monetary cost of effort select predominantly into stand-alone contests, while so-called weak players with a high monetary and/or non-monetary effort cost predominantly enter into endogenously formed alliances. Strong players are "exploited" by their alliance partner who free-rides on them. These strong players have a higher expected empirical payoff in the stand-alone contest which can explain their preference for standing alone.

The self-selection of weak players leads to lower effort in endogenously formed alliances. Yet, the evidence found suggests that there is also an effort-stimulating effect whenever players voluntarily form an alliance. This is the case because those players who care a lot about their in-group select into the alliance and because in-group solidarity is enhanced. This increase in effort is in line with theories of in-group favoritism and partially counterbalances the negative effect of self-selection.

We have also found evidence for strategic effects as effort choices depend on the co-player's vote on alliance formation. Strong players who end up in an alliance with a player who voted for alliance formation choose the highest effort anticipating that their alliance partner is likely to be a weak type and is likely to expend little effort. Similarly, weak players with a preference for alliance formation choose the lowest effort when they are in an alliance with a co-player who voted against alliance formation. These intuitions have been confirmed by an additional treatment in which we also elicited player's beliefs about their co-player's effort. Last, we analyzed institutional questions regarding the process of alliance formation. We find that when alliance formation decisions require unanimity (instead of majority), the individual probability of voting for alliance formation is higher than under majority voting.

1.2.2 Balance of power

In this chapter, we study the role of an imbalance in fighting strengths when players bargain in the shadow of conflict. More specifically, we analyze the relation between power asymmetries of players and, first, the probability of a resource wasteful conflict as well as, second, the distribution of the surplus created from reaching a peaceful solution. This chapter relates to the literature on bargaining and the role of asymmetries, to research in the context of evolutionary game theory, and to the large literature in political science addressing the balance of power and the probability of war. Balance of power theory predicts that conflict is most likely to break out if the players have very different strengths. Power transition theory, on the contrary, predicts that conflict is most likely to break out if the players have roughly similar strength. An influential argument by Wittman (1979) suggests that the balance of power should not matter for the probability of military conflict; it should only matter for the distribution of the resources. We take this hypothesis as our starting point in the experiment. In the experiment, players differ in monetary effort cost. They first bargain about the division of some resource and only if they fail to reach a peaceful agreement they enter into conflict.

Our experimental results suggest the following: First, whether or not an increase in power asymmetry between players leads to more conflict depends on the exact specification of the bargaining stage. Second, the importance of exogenous mediation proposals depends on the balance of power.

In a simple bargaining game with an exogenous mediation proposal, the likelihood of conflict is independent of the balance of power. A larger imbalance of power does not influence the likelihood of conflict in case of such an exogenous division mechanism. This mechanism can be thought of as a mediator without own objectives who offers an equitable division of the prize (the Nash bargaining solution) to the players. On the individual decision level, we find that the disadvantaged player rejects the proposed division more often than the advantaged player. However, if the mediator suggests a 50-50 split of the prize, then the player who is advantaged in the contest is more likely to reject. If the exogenous mediation proposal does not account for changes in the relative fighting strengths at all, the conflict probability is substantially increased. These findings can be rationalized by relative standing considerations and are in line with findings from evolutionary biology.

If we move away from the exogenous division of the prize and if instead bargaining involves endogenous demand choices, the results are different. With endogenous demands, the likelihood of conflict is higher if power is more imbalanced. Endogenous bargaining outcomes reflect the players' unequal fighting strengths, and outcomes are most efficient when power is balanced. With small power asymmetry, players successfully implement an endogenous peaceful 50-50 split in about half of the cases. Comparing the bargaining mechanisms, exogenous mediation proposals even lead to more conflict than own demand choices in the negotiations if power is balanced.

If power asymmetry is large and bargaining follows the rules of a Nash demand game, we observe a significant amount of conflict. Conflict arises in more than half of the cases because total demands by both players are incompatible. The mere possibility to appropriate a larger part of the resources (that is absent in the simple game with an exogenous mediation proposal) makes players less willing to compromise. If a peaceful agreement is reached, however, the entire material surplus of peaceful sharing is allocated to the disadvantaged player. The advantaged player only gets a share close to his conflict payoff (his outside option).

We rule out a number of individual reasons for the high amount of conflict in the treatment with endogenous demand choices and a large asymmetry in fighting strengths. First, the high probability of conflict cannot be due to efficiency considerations only. It is true that total rent dissipation in the conflict decreases in the degree of asymmetry, making bargaining failure more costly when players are similar in terms of their fighting strengths. Hence, reaching a peaceful agreement is more valuable if players are very similar in terms of fighting strength. However, this efficiency argument should also hold for the simple exogenous bargaining mechanism, but we find no influence of power balance on the probability of conflict in this institutional setup. Furthermore, coordination failure can only be a partial explanation for the increased conflict probability as the conflict probability remains high even when the equitable solution chosen by the mediator is suggested as a focal point to the players. The increased conflict probability when asymmetry between players is high may stem from increased individual heterogeneity, for example in the value of winning.

1.2.3 Joy of winning

A widely observed phenomenon in lottery contest experiments is that players significantly overexpend effort, compared to a theoretical benchmark. One common explanation for this overbidding is that players value the prize higher than its pure monetary value, the so-called joy of winning yields additional utility for them. This can not only explain the overexpenditure, but also the heterogeneity in contest efforts observed. However, while the existence of a joy of winning is increasingly accepted in the literature discussing experimental contests, there is little undisputed empirical evidence for such a joy of winning because the joy of winning is difficult to observe and to quantify.

The most prominent test for an inherent joy of winning has been developed by Sheremeta (2010b): After the main part of a contest experiment, players can invest effort in another contest, in which the prize value is set to zero. They are actually fighting for nothing. The effort expended in this zero-prize-contest is then taken as a measure for the joy of winning. This post-test has been implemented by a number of recent contest experiments. However, the measure is also challenged, e.g., because of its post-test nature and because it is a one-sided measure in that it cannot measure the frustration of losing.

Therefore, this chapter develops a novel, incentivized way to measure the individual-specific joy of winning as well as the frustration of losing in a Tullock lottery contest. Two players first take part in a Tullock contest and once they know their realized payoffs, they can place a (negative or positive) bid for playing again. This bid for playing again is then compared to a predicted bid whose value is derived from theory. Using this comparison, it is possible to test whether the players over- or underbid for playing the contest again. Moreover, the players report their current satisfaction levels right before and after the contest, yielding a non-incentivized measure for the joy of winning and the frustration of losing.

We find that the willingness to pay for a restart of the contest differs between winners and losers. Compared to a theoretical benchmark, winners are more satisfied and overbid for a restart of the contest, indicating a joy of winning. On the contrary, losers are less satisfied and underbid, indicating a frustration of losing. In both dimensions, we observe a large degree of heterogeneity across our players. We find a monotonicity in changes in satisfaction that are induced by the restarted contest. Former losers (winners) and later winners (losers) experience the highest increase (decrease) in satisfaction. Both measures of the joy of winning, bid differences and the change in satisfaction, are significantly positively correlated, but they are uncorrelated with the effort players expend in a zero-prize contest.

The implementation of the experiment allows us to test another hypothesis. Winning probabilities were illustrated by means of a fortune wheel with an arrow spinning clockwise on the screen. Hence, we have (visually) bare winners and losers versus sure winners and losers, depending on whether the arrow stopped close to the frontier between both players' winning regions or far away. In line with findings from psychology on narrow misses, we find that visually tight outcomes lead to stronger reactions (both for the bid differences and for the change in satisfaction). Moreover, we test whether the joy of winning is higher the lower the actual win probability of a player. We find that the magnitude of the joy of winning and of the frustration of losing is larger when winning or losing comes as a surprise, in line with former results that surprise enhances emotional effects.

Further, effort levels (which are higher than predicted in the first contest) are even higher in the second contest, which can be explained by selection of high effort types with a high joy of winning into the restarted contest. On average, players who continue to the restarted contest expend more effort in the first contest than players who do not continue to the restarted contest. Moreover, the new composition of players (biased towards high joy of winning types who expend a lot of effort) leads the subset of players who continue to the restarted contest to increase their effort in the restarted contest even further.

1.2.4 Self-selection of joyful players

Expenditures in a contest can either be a good or a bad, depending on the application. For example, rent-seeking expenditures are normally seen as social waste because a welfare maximizing social planner would try to minimize them. The same is true for patent races and obviously for military conflict (not taking into account positive effects on innovations and the defense industry). On the other hand, the effort expended by potential candidates in promotion contests can be viewed as something good if the effort increases the knowledge frontier or more generally contributes to the company's output. Innovation effort is also typically seen as a good and a social planner approves of the positive externalities from increases in research and development spending. Also in sports tournaments the effort expended in training and in matches has positive externalities and is viewed as a good that should be maximized from a planner's perspective. Hence, in some applications the contest organizer may wish to maximize expenditure and in other applications he may wish to minimize expenditure.

In chapter 5, we build on the experimental set-up of chapter 4. We take the perspective that effort is a good and analyze the decision of an effort-maximizing contest designer on whether to allow for a restart of the contest, inducing self-selection of joyful players. We show that letting players self-select into a contest according to their joy of winning can lead to higher effort levels in the contest. We employ a complete information model with two types who differ in their degree of the joy of winning. Due to the increased incentives for joyful players who care about the monetary value of the prize and about winning per se, effort expended by joyful types is higher than effort expended by types who only care about the monetary value of the prize.

We assume that there is asymmetric awareness between contestants and the contest designer about the end of the game. Contestants might know that a restart might occur, but we simplify the analysis by assuming that they ignore this probability when they decide on their first period effort. After the contest, the players learn that they can bid money to have the chance to replay the contest and that the monetary consequences of the former contest are eliminated upon restarting. On the one hand, joyful players in our model include the expected joy of winning in the expected payoff of a restarted contest. This raises their bids for a restart of a contest. On the other hand, joyful players prefer playing against those types who only care about the monetary value of the prize. We show that more of the joyful types than of the types without a joy of winning end up in the restarted contest. Sorting along the joy of winning leads to an increase in average effort, which is beneficial for a contest designer who wants to maximize average effort.

We also show that adding a potential frustration of losing as a non-monetary component to the utility function cannot explain the increase in effort in the restarted contest. Effort by players with a frustration of losing is higher than effort by players who are motivated by monetary incentives only. However, the players with a frustration of losing bid less for playing a contest again and therefore are less likely to end up in the restarted contest, so that self-selection has the opposite effect to the framework with joyful players. Moreover, we emphasize that the results rely on the fact that the joy of winning is a non-monetary component. This component cannot be eliminated even if the contest in which the player won is not selected for payment.

Chapter 2

Endogenous group formation in experimental contests

This chapter is joint work with Kai Konrad and Florian Morath. It is based on the article *Endogenous group formation in experimental contests,* published in *European Economic Review*, 2015, Volume 74, p. 163-189. Please see http://dx.doi.org/10.1016/j.euroecorev.2014.12.001.

Chapter 3

Balance of power and the propensity of conflict

This chapter is joint work with Kai Konrad and Florian Morath, it is based on the article *Balance of power and the propensity of conflict,* forthcoming in *Games and Economic Behavior*. Please see http://dx.doi.org/10.1016/j.geb.2015.12.013.

Chapter 4

Who pays to win again? The joy of winning in contest experiments

4.1 Introduction

Redistributing resources by fighting a contest may in addition to allocative implications also have more subtle consequences for the contest participants: The winner of the contest may enjoy the pride and happiness of winning and being first, while the loser of the contest may suffer from his failure and be frustrated by having exerted effort in vain. This may be true for a variety of contests between individual decision-makers, be it promotion contests, sports contests or political contests. For some applications such as board games, victory even comes without any allocative or monetary consequences. In these contests, especially if there is a lot of randomness in individual performance, non-monetary effects such as the so-called joy of winning seem to be a major motivation for why people strive to be first.[1]

In the experimental economics literature, the joy of winning has been used to explain overexpenditure in lottery contests, compared to a theoretical benchmark.[2] The intuition is that players value the prize higher than its

[1] This chapter is based on Herbst (2016b), Max Planck Institute for Tax Law and Public Finance Working Paper 2016-06.

[2] A variety of explanations exist for why people overexpend effort. Sheremeta (2016)

pure monetary value, in other words, they derive additional utility from the fact that they have won. If the extent of the additional utility differs across individuals, the joy of winning can not only explain the overexpenditure, but also the heterogeneity in contest efforts observed. Due to its explanatory power, the existence of a joy of winning is increasingly accepted in the literature discussing experimental contests (e.g., Brookins and Ryvkin 2014, Cason et al. 2013, Hart et al. 2015, Herbst et al. 2015, Mago et al. 2013, Morgan et al. 2016, Price and Sheremeta 2011 and 2015, Rockenbach and Waligora 2016). The acceptance is also reflected by the fact that more and more theory models on lottery contests include it.[3] Nevertheless, there is little undisputed empirical evidence for such a joy of winning in experimental contests. The lack of strong empirical evidence is the main motivation for this chapter.

The most prominent test for an inherent joy of winning in experimental contests has been developed by Sheremeta (2010b): After the main part of a contest experiment, players can invest effort in another contest, in which the prize value is set to zero. That is, the players are actually fighting for nothing. The effort expended in this zero-prize-contest is then taken as a measure for the joy of winning. This post-test has been implemented by a number of recent contest experiments (e.g., Brookins and Ryvkin 2014, Cason et al. 2013, Herbst et al. 2015, Mago et al. 2013, Price and Sheremeta 2011 and 2015). Yet, some open questions remain: Are some players just too tired and fatigued at the end of the experiment that they do not pay full attention to the experimental task? Are their effort choices in a zero-prize-contest therefore merely a repetition of previous effort choices? Thus, the reliability of this measure is questionable. Moreover, the effort in a zero-prize-contest is a one-sided measure in that it cannot yield any insights on the frustration of losing. Without further controls, it is also impossible to disentangle the joy of winning from the joy of playing a lottery.

The contribution of this chapter is twofold. First, we introduce an al-

tests a number of different reasons for this phenomenon, with the joy of winning being one of them.

[3]See for example Kräkel (2008). More recently, Cotton et al. (2015) and Metzger (2015) model players with heterogeneous values of winning a prize, referring to the joy of winning. Gauriot and Page (2016) also include the utility of winning in their model to rationalize empirical data from tennis matches.

ternative experimental way to measure the joy of winning. Second, we also measure the frustration of losing, which allows us to test for asymmetries between being ahead and behind. We test for both of these non-monetary utility effects in two different ways, one incentivized and one non-incentivized. For the incentivized part, two players first take part in a Tullock lottery contest. Once they know their realized payoffs, they can place a (negative or positive) bid for playing the contest again. The model framework yields a prediction for this bid for playing again, against which we can compare the observed bid. With this comparison, we can test for over- or underbidding as regards playing the contest again. Additionally, we can differentiate between players that have won or lost prior to the decision on bidding for a restart. For the non-incentivized part, the players are asked about their current satisfaction level with respect to their experience in the experiment right before and right after the contest. This is in line with the usual practice of using self-reported emotional states which has recently been introduced into experimental economics and which is a proxy for a player's utility.[4] An additional contribution is that we dive further into some different dimensions of the joy of winning and the frustration of losing. More specifically, we test whether the joy of winning and the frustration of losing depend on the outcome being expected or unexpected and on the outcome seeming to be narrow or clear.

The results show that compared to the prediction, winners bid too much for a restart of the contest and losers bid too little, indicating a joy of winning for winners and a frustration of losing for losers. Emotionally, winners report to be more satisfied than losers, although the difference can also be explained by monetary payoffs. Both measures of the joy of winning, overbidding and the change in satisfaction, are significantly positively correlated, but they are uncorrelated with the effort players expend in a zero-prize contest (Sheremeta, 2010b). Furthermore, effort levels in the repeated contest are higher. This alludes to both selection and behavioral effects: The restarted contests attracts high effort types and induces stronger competition.

[4] Lang and Morath (2015) recently used it in their experiment and Perez-Truglia (2015) provides a validation test of using stated subjective well-being data.

This chapter is related to different strands of the literature. First and foremost, Sheremeta (2010b) developed a direct test for the joy of winning in experimental contests as discussed above. Yet, the joy of winning has also been under investigation in other contexts. With a psychometric approach, i.e. analyzing data from extensive questionnaires, Franken and Brown (1995) analyze how the importance of winning differs between different individuals. Ding et al. (2005) study how the joy of winning influences bids in internet auctions. Malhotra (2010) also uses bids in online auctions to study competitive arousal from a decision-making aspect, which is also the focus of a paper by Malhotra et al. (2008). Coffey and Maloney (2010) study the "thrill of victory" with data from dog and horse races and Matsumoto and Willingham (2006) study the thrill of victory with photos of facial expressions from judo competition winners. Unlike these papers, we are interested in the joy of winning in the experimental laboratory. The laboratory also provides a controlled environment and the possibility to incentivize individual decisions from which we deduce the joy of winning and the frustration of losing.

The consequences of winning and of losing are the focus of some other papers: Bühren and Pleßner (2014) show that winners are more likely to pay for actually getting a physical trophy, Kidd et al. (2013) find that winning increases generosity, especially if winning comes unexpectedly, Kasumovic and Kuznekoff (2015) show that losers of a video game make more negative and more sexist comments, Buser (forthcoming) shows that following a loss, players set a higher performance target for themselves, while Johnson and Salmon (2016) show that low ability subjects get discouraged from not being promoted if promotion decisions are unrelated to ability. Cowley (2008) analyzes internal justification decisions of winners and losers to replay a game, finding no difference between winners and losers. Wadhwa and Kim (2015) show that nearly winning a computer game increased participants' motivation to expend effort on unrelated future tasks. We also look at the consequences of winning or losing, with a special interest on the player's willingness to play the contest once more. This yields a simple measure for the joy of winning and the frustration of losing at the same time.

One of the first papers to study emotions in the laboratory more generally is by Mellers et al. (1997). They use self-reported emotional states to point at the emotional aspect of decision making. Brandts et al. (2009) study the impact of rivalrous situations on subjective well-being in general and more specifically on happiness and joy (among other emotions). They find that joy is positively correlated with success in a two-player social dilemma interaction. Adam and a number of coauthors (Adam et al. 2011a, 2011b) have measured emotions using physiological measures and psychometric scales. Using skin conductance rates, Astor et al. (2013) and Adam et al. (2015) find that depending on the specific type of auction, the joy of winning can be smaller or larger than the frustration of losing. Using functional Magnetic Resonance Imaging techniques, Dohmen et al. (2011b) show that solving a task that a comparison subject has not solved positively affects reward-related brain areas. Haran and Ritov (2014) find that the self-reported anticipated sadness of losing more strongly influences bids in a first-price sealed-bid auction than the self-reported anticipated happiness of winning does. Bosman et al. (2014) also use self-reported emotions and find that winners of a random lottery experience more positive emotions and positive surprise than losers, with positive consequences on option price estimates. While it is informative to analyze the joy of winning under all kinds of rivalrous conditions, auction and contest types, we choose the Tullock lottery contest as our focus of interest, also following the literature that begins with Sheremeta (2010b).

In the next Section we introduce the model framework, line out the experimental design and explain our hypotheses. We analyze and discuss the empirical data in Section 4.3 and provide concluding remarks in Section 4.4.

4.2 Framework

4.2.1 Theory background

There are two players A and B that fight for a prize of monetary value V in a Tullock lottery contest. In a first stage, both players simultaneously choose effort x_i, $i = A,\ B$, which influences their winning probability. The unit cost of effort is assumed to be constant and equal to one. Player i's probability of winning the prize is equal to

$$p_i\left(x_A, x_B\right) = \frac{x_i}{x_A + x_B}, \quad i = A, B$$

if $x_A + x_B > 0$ and equal to 1/2 otherwise. Player i's expected payoff is

$$E\pi_i\left(x_i\right) = p_i(x_A, x_B)V - x_i, \quad i = A, B,$$

that is, i's expected payoff is equal to his probability of winning multiplied by the prize, minus the effort cost.

Player i maximizes his expected payoff $E\pi_i$ and invests $x_i^* = \frac{V}{4}$ in equilibrium. This yields an equilibrium expected payoff of $E\pi_i^* = \frac{V}{4}$. By construction, there will be a winner and a loser in this contest. Realized ex post payoffs are $\pi_W = V - x_W$ for the winner and $\pi_L = -x_L$ for the loser, where x_W and x_L describe the effort exerted by the winner and loser, respectively.

Once the realized payoffs are known, players can bid $b_i \in [-V, V]$, $i = A,\ B$, for a restart of the contest in a second stage. If the sum of these bids, $b_A + b_B$, is positive, the game is restarted. A restart means that the payoff from the former contest is cancelled and instead the payoff from the new contest will be relevant for payment. Otherwise, if $b_A + b_B \leqslant 0$, the payoff from the former contest is relevant for payment and the players do not enter into the second contest. In our setup, inspired by the Vickrey Clarke Groves mechanism, only the pivotal player actually pays a bid to the laboratory and the absolute value of this bid is determined by the second-highest bid. The final payment Π that players earn in the contest stage will thus be either the payoff from the new contest minus a positive bid for a restart (i.e. plus the negative bid of the other non-pivotal player) if the player was pivotal in the decision for a restart (case 1 below). It can be the payoff from the new contest (case 2 below) or the payoff from the old contest (case 3 below). Finally, it will be the payoff from the old contest minus a negative bid for a restart (i.e. plus the positive bid of the other non-pivotal player) if the player was pivotal in the decision against a restart (case 4 below). Formally, final earnings Π_i will be

$$\Pi_i = \begin{cases} \pi_{i,new} + b_{-i} & \text{if } b_i > 0 \wedge b_{-i} \leqslant 0 \wedge b_i + b_{-i} > 0 \\ \pi_{i,new} & \text{if } (b_i > 0 \wedge b_{-i} > 0) \vee (b_i \leqslant 0 \wedge b_{-i} > 0 \wedge b_i + b_{-i} > 0) \\ \pi_{i,old} & \text{if } (b_i > 0 \wedge b_{-i} \leqslant 0 \wedge b_i + b_{-i} \leqslant 0) \vee (b_i \leqslant 0 \wedge b_{-i} \leqslant 0) \\ \pi_{i,old} + b_{-i} & \text{if } b_i \leqslant 0 \wedge b_{-i} > 0 \wedge b_i + b_{-i} \leqslant 0 \end{cases}$$

Given this setup, the players who value a restart positively (losers) have no incentive to understate their willingness to pay, but may have an incentive to overstate their willingness to pay.[5] The players who value a restart negatively value (winners), on the other hand, might have an incentive to understate their willingness to pay, but never have an incentive to overstate their willingness to pay.[6]

Here, we concentrate on the equilibrium in weakly dominant strategies in which both players state their true willingness to pay. Thus, both players bid their true value of a restart, i.e.

$$b_i = E\pi_{i,new} - \pi_{i,old}. \tag{4.1}$$

[5] As an illustration take a loser who has invested $x_L = 150$ in the first contest (corresponding to a payoff of $\pi_L = -150$), which he takes into account when deciding on his bid, and expects $E\pi_{new} = 125$. His true value for a restart is thus $b_i = 275$. If he expects the other player to say $b_{-i} = -275$, then stating $\hat{b}_i = 276$ instead of $b_i = 275$ increases his expected earnings from -150 (payoff from the old contest) to 0 (payoff from the new contest minus bid minus payoff from old contest, $125 - 275 + 150 = 0$). That is, losers may have an incentive to overstate. Stating $\hat{b}_i = 274$ does not change expected earnings if the player expects the other player to say $b_{-i} = -275$. If he expects the other player to say $b_{-i} = -274$, then stating $\hat{b}_i = 274$ decreases expected earnings from 1 ($125 - 274 + 150$) to -150. Stating $\hat{b}_i = 276$ does not change expected earnings if the player expects the other player to say $b_{-i} = -274$.

[6] As an illustration take a winner who has invested $x_W = 150$ in the first contest (corresponding to a payoff of $\pi_W = 350$), which he takes into account when deciding on his bid, and expects $E\pi_{new} = 125$. His true value for a restart is thus $b_i = -225$. If he expects the other player to say $b_{-i} = 225$, then stating $\hat{b}_i = -226$ instead of $b_i = -225$ increases expected earnings from 350 (payoff from the old contest) to 575 (payoff from the old contest minus bid, $350 - (-225) = 575$). That is, winners may have an incentive to understate. Stating $\hat{b}_i = -224$ decreases expected earnings from 350 to -225 (payoff from the new contest minus payoff from the old contest, $125 - 350 = -225$).

that is, players bid the expected payoff from the restarted contest, $E\pi_{i,new}$, minus the payoff from the old contest that will be cancelled if the second contest is played, $\pi_{i,old}$. Therefore, in equilibrium we have $b_W = -\frac{V}{2}$ for the winner and $b_L = \frac{V}{2}$ for the loser. Hence, the sum of both bids is zero in this sharp equilibrium prediction and the contest is never restarted.

4.2.2 Experimental procedures

The experiment was programmed using z-Tree (Fischbacher 2007) and run at the econlab laboratory in Munich, Germany. Subjects were recruited from the student body of Munich universities using ORSEE (Greiner 2004). We admitted 8 subjects to each session (104 participants in total), giving us 26 independent observations (4 subjects per matchinggroup). Subjects were on average 26 years old, a quarter of them studied an economics-related subject and 53% were male.

At the beginning of each session, written instructions were distributed and read out loud (see Appendix 4.B for a translation of the instructions). To make sure that subjects understood the experiment, they had to complete a quiz. This quiz included multiple-choice questions on the tasks described in the instructions and the payoff consequences of different decisions. When the experiment started, subjects had to count the number of zeros in five rows of 15-digit number strings composed of "0"s and "1"s.[7] Upon successful completion of a series of these (which was guaranteed by immediate feedback and the chance to correct a mistake in case it occurred), subjects received 750 tokens (which corresponded to 15 euros) for this task. These tokens served as their endowment for the subsequent parts of the experiment. This real effort task was implemented to avoid a house money effect.

In order for subjects to get familiarized with the contest environment, there were four rounds of the contest against a computer-animated player. The rules of this first stage of the contest were as described above with the prize value being equal to $V = 500$ tokens. The subjects' maximum effort choices were restricted to $x^{\max} = \frac{V}{2}$, which is twice the equilibrium

[7] A similar task of counting zeros has been used by Kleine et al. (2016), and we are grateful for access to their experimental program.

prediction and thus sufficiently far from a binding restriction.[8] Both players chose their effort as a non-negative integer. The computer's effort choices and their order were pre-selected by the experimenter and replicated typical effort choices of human contestants in an experimental two-player Tullock lottery contest, i.e. there was some over-spending (on average 25% higher than the equilibrium prediction) and a tendency towards focal numbers (going for multiples of 25). The resulting win probabilities were illustrated in a circular area on the screen, with a pointer running clockwise determining the winner (compare the screenshot in Appendix 4.A.1). Once the arrow had stopped, the subjects learned their payoff from this contest. The rounds against the computer provided ample learning opportunities for the subjects, with more than 90% of subjects experiencing both victory and loss in these rounds, although these rounds were not paid out and therefore involved no monetary consequences. Note that if the joy of winning is a phenomenon that disappears with learning, these four first rounds make it more difficult for us to find an effect.

Before the subjects entered into the contest against a human contestant, they had to answer "how happy or satisfied they are at the moment" (that is the translation of the exact wording in the experiment), on a scale from 0 to 10. For the contest, the subjects were randomly and anonymously matched in groups of two, with everything else equal to the contest rounds against the computer. Once subjects learned the outcome of the contest and the round was finished, the next screen reminded players of their contest payoff and of the fact whether they had won or lost. They were then again asked about their current satisfaction.[9] By comparing this answer to the self-reported level of satisfaction before the contest, we have a direct measure for the effect of winning or losing.

Afterwards, a new part started whose details were only announced to the subjects after they finished the first contest against a human contestant. In this part, the subjects could place a (positive or negative) bid for eliminating

[8]Admittedly, in the experiment about 15% of the observed effort choices are at this limit. However, restricting effort choices was necessary to avoid possible overall losses by subjects in the experiment.

[9]The screen said: "You have just (not) won the 500 tokens. Your payoff is xxx tokens. How happy or satisfied are you at the moment?"

the result from the first contest and playing another contest round. Apart from the new matching, the setup of the restarted contest was exactly as the former contest, also including the question on current satisfaction after learning the outcome of the restarted contest. We did not want the subjects to base their bidding decision on social preferences towards their specific co-player in the former contest, therefore, two players were again matched at random. Yet, we made sure to match a winner with a loser, although this feature was unknown to the subjects. A bid for a restart had to be a positive or negative integer between $-V$ and V. If the sum of both players' bids was positive, a new contest was played. Otherwise, if the sum of both players' bids was non-positive, the players moved directly on to the post-tests. In any case, only the pivotal player needed to pay a bid (i.e. he was to receive money if he placed a negative bid and was pivotal) and this was explained to the subjects in great detail and with a number of examples.[10]

Subsequently, the subjects underwent a number of incentivized tests. First, we elicited their preferences for playing a lottery (which was similar to the contest, but subjects had to decide whether to invest a fixed amount of tokens at a given win probability), then their distributional preferences (subjects had to repeatedly make two-person allocation decisions, following Bartling et al. 2009 and Balafoutas et al. 2012), effort in Sheremeta's (2010b) zero-prize contest (which is widely used as a measure for the joy of winning) and their ambiguity aversion. Moreover, in the questionnaire the subjects were asked about their risk aversion (see Dohmen et al. 2011a), optimism, pessimism, loss aversion, experience in board games and other competitions and a number of socioeconomic characteristics.

At the end of the experiment the subjects were paid separately and in private. The conversion rate was 50 tokens = 1 euro. Each participant received a show-up fee of 6 euros, the earnings (possibly negative) of the first or second contest against another human player (including bidding) and the payoff (also possibly negative) from one randomly selected post-experimental task. On average, subjects earned 25 euros (excluding the show-up fee), and a session took about one hour.

[10] See the survey by Chen and Ledyard (2008) on how well different mechanisms to elicit the willingness to pay perform in the laboratory and Fukuda et al. (2013) for a more recent experiment using the Vickrey Clarke Groves mechanism.

4.2.3 Hypotheses

In equilibrium the expected contest payoff is $E\pi_i^* = \frac{V}{4}$. Rearranging the value of a restart (4.1), we get $E\pi_{i,new} = b_i + \pi_{i,old}$, i.e. the expected payoff from a new contest should be equal to the bid for playing this contest plus the payoff from the old contest, where the latter two can both be observed in the experiment. Taking the two expressions for the expected payoff together, we have $b_i + \pi_{i,old} - \frac{V}{4} = 0$. If players value playing the contest a second time higher than its monetary value, this expression will not be equal to zero, in other words $E\pi_{i,new} \neq E\pi_i^*$, but $E\pi_{i,new} = E\pi_i^* + \Delta_i$. Hence, the difference Δ_i (our measure of interest) is given by

$$\Delta_i = b_i + \pi_{i,old} - \frac{V}{4}. \tag{4.2}$$

Even if the players expect to enjoy a joy of winning with some probability in the restarted contest, there should be no difference between winners and losers. However, if the joy of winning (and equivalently, the frustration of losing) persist for whatever reason even after the monetary payoff from this contest is eliminated, then only winners include a joy of winning in their expected payoff of a future contest and losers include a frustration of losing in their expected payoff of a future contest.[11] According to this interpretation, we expect that the term Δ_i is positive for winners of the first contest and that Δ_i is negative for losers of the first contest. Independent of winning or losing, a possible (persistent) joy of playing the lottery would increase Δ_i. Hence, the number Δ_i that we find is an upper bound for the joy of winning and a lower bound for the frustration of losing. However, such a joy of playing the lottery cannot explain a difference in the measure Δ_i between winners and losers.

Note that overbidding for playing again should not be confused with overexpenditure in the contest. Taking overexpenditure into account, the expected payoff from the restarted contest as well as the payoff from the old contest will be lower.[12] The latter is accounted for individually as this

[11] A similar prediction arises if there are biases in evaluating probabilities and winners scale up their probability of winning and losers scale down their probability of winning.

[12] This also has consequences for the sum of both players' bids. The sum of bids is expected to be positive if there is overexpenditure in the first contest only and negative

payoff is observed. The former cannot be observed directly, but it would work against a joy of winning, with a lower expected payoff from a restarted contest decreasing rather than increasing the bids for replay.

Let us now turn our attention to the non-incentivized measure. We expect to see an increase in satisfaction after winning the contest and a decrease in satisfaction after losing the contest. These measures can also be used to test whether the magnitude of the effect on satisfaction is larger for winners or for losers.

Alongside the basic hypotheses on overbidding and increased satisfaction and the general measurement of the joy of winning, a special feature of the design allows us to test another hypothesis. Winning probabilities were illustrated by means of a fortune wheel with an arrow spinning clockwise on the screen. Hence, we have (visually) bare winners and losers versus sure winners and losers, depending on whether the arrow stopped close to the frontier between both players' winning regions or far away (compare the screenshots in Appendix 4.A.1). We expect that the joy of winning and the frustration of losing are intensified if the victory or the loss seemed to be a tight one. This would be in line with results from Bossuyt et al. (2014) from a slot-machine experiment. They find that proximity of a loss increases a player's tendency to repair the outcome by betting again, but it has no influence on the degree of frustration.[13] They could not manipulate the proximity of a win in their study nor was the outcome influenced by the participants themselves. However, they also show that unexpected losses lead to intensified feelings of disappointment and frustration and that unexpectedness also increases a player's tendency to bet money to play the machine again. We also study whether the joy of winning is higher the lower the actual win probability of this player. Although the theory predicts no difference in these, Mellers et al. (1997), Bossuyt et al. (2014) and Kidd et al. (2013) show that surprise enhances emotional reactions.

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if overexpenditure is expected in the restarted contest only. The sum of bids will again equal zero if overexpenditure is of the same extent in both contests and symmetric for both players.

[13] Dillon and Tinsley (2008) show that participants in their study evaluate near-misses similar to successes. If this also holds in our experiment, then close losses would be evaluated more similar to victories and hence the frustration of losing would be smaller.

	Winner	Loser	p-value
Bid b_i	-50.6	55.7	0.002
	(14.9)	(11.0)	
Bid difference Δ_i	145.6	-190.1	0.002
	(17.4)	(12.4)	
Change in satisfaction Δs_i	1.25	-1.13	0.003
	(0.17)	(0.38)	

Table 4.1: Bids, bid differences and change in satisfaction.

Note: Separately for winners and losers. Standard errors in parentheses, grouped at the matching group level. P-values for testing whether differences between winners and losers are zero.

4.3 Results

4.3.1 Non-parametric analysis

We begin the analysis by comparing the bids that winners and losers place for playing the contest a second time. Irrespective of the expected payoff from the new contest, winners give up a gain whilst losers forego a loss when the payoff from the old contest is eliminated. Thus, if the players in the experiment have a correct understanding of their incentives, bids by winners should be lower than bids by losers. Table 4.1 shows that on average winners bid $b_W = -50.6$ and losers bid $b_L = 55.7$. (For comparison purposes, average expected bids are $Eb_W = -196.2$ and $Eb_L = 245.8$.) As predicted, there is a significant difference between the two groups (p-value < 0.01, Mann Whitney U test at the matchinggroup level). The histogram of the bids (in Appendix 4.A.2) shows that bids of winners are left-skewed and those of losers right-skewed. It also illustrates that more than 35 % of the bids fall in the narrow range from -10 to 10. Despite the fact that the sum of bids does not significantly differ from zero, 46 % of the subjects moved on to a restart of the contest.

The focus of this chapter is to measure both, the joy of winning by the extent that winners overbid, and the frustration of losing by the extent that losers underbid. Therefore, we will now compare the observed bids with the theoretical prediction, taking into account individual payoffs from the first contest. Does the measure $\Delta_i = b_i + \pi_{i,old} - \frac{V}{4}$, which measures the difference of the observed bids to the expected value of a restart of the contest, differ between winners and losers? Table 4.1 presents evidence on a clear and significant difference between the joy of winning $\Delta_W = 145.6$ and the frustration of losing $\Delta_L = -190.1$ (p-value < 0.01, tested at the matchinggroup level). Winners' bids are less negative than the predicted negative bids and losers bid a lower positive value than the predicted positive bids. The differences are in line with our hypothesis that winning is valued more highly than the prize itself and that losing comes with some depression. The differences cannot be explained by strategic incentives of the bidding mechanism, as winners may have an incentive to underbid, but not to overbid, and losers may have an incentive to overbid, but not to underbid, as explained above. Comparing the magnitude of both effects we find that the frustration of losing is larger than the joy of winning (p-value $= 0.09$) in line with findings from experiments on loss aversion according to which a loss is more painful than an equivalent gain is pleasurable and the general insight that bad is stronger than good (Baumeister et al. 2001).[14]

Result 4.1 *After winning a contest, players bid more than the expected value of a restart for playing the contest again. After losing a contest, players bid less than the expected value of a restart for playing the contest again.*

The scatterplot (in Appendix 4.A.3) depicts the dispersion of bids across the bid-effort-space. We find a clear dichotomy between winners and losers. There is only a very low number of subjects who underbid upon winning and overbid upon losing (5 subjects in total). The incentivized measure suggests that the joy of winning as well as the frustration of losing exist and that they vary across subjects and across effort levels.[15]

[14]Note that the difference cannot be explained by a joy of playing the lottery because such a joy increases both numbers.

[15]One way to understand the heterogeneity is to look at correlation coefficients between bid differences and individual-specific characteristics. Most of the characteristics we observe are not robustly correlated with the joy of winning measure. However, we find

Now let us consider the satisfaction measure for the joy of winning. As a first plausibility check of the data, we compare the satisfaction of winners and losers after the first real contest. We find that on a scale from 0 to 10, winners on average report a level of $s_W = 7.85$ and losers on average report a level of $s_L = 5.23$, which is significantly lower (p-value < 0.01, tested at the matchinggroup level). In principle, being inclined to be a winner and being in a generally happier mood could be systematically correlated. Thus, a cleaner test for the effect of winning or losing on satisfaction can be obtained by looking at the change in satisfaction that is induced by the contest. Table 4.1 shows that the affective reaction, i.e. the change in satisfaction Δs_i, is positive for winners and negative for losers, reinforcing the result on the incentivized measure for the joy of winning. The magnitude of the difference in satisfaction is basically the same for winners and losers (p-value $= 0.94$).

Result 4.2 *The self-reported satisfaction of players who won a contest significantly increases, whereas the self-reported satisfaction of players who lost a contest significantly decreases.*

Remember that we also asked the subjects who replayed the contest for their current satisfaction after playing the second contest. Here, the reactions to winning or losing are even more pronounced with the change induced by winning the second contest being equal to $\Delta s_{2,W} = 1.41$ and the change induced by losing the second contest being equal to $\Delta s_{2,L} = -2.85$. Table 4.2 includes an analysis on a more detailed level, separating these effects according to whether the player had been a winner or a loser in the former contest, i.e. whether the player's eliminated payoff was positive or negative. As before, the change in satisfaction is more positive if players end up being a winner in the new contest (for both rows, p-value $= 0.07$ for testing column differences). The affective reaction depends very much on the outcome of the former contest of which the payoff is eliminated: Independent of being a winner or a loser now, the change in satisfaction is more positive if the player had been a loser in the former contest (for both columns, p-value $= 0.07$ for testing row differences).

that envious subjects (deduced from two-person allocation decisions) have a significantly higher joy of winning or frustration of losing.

	Restarted contest outcome:	
Change in satisfaction Δs_{2i}	Winner	Loser
Winner in former contest	0.42	-5.11
	(0.40)	(1.15)
Loser in former contest	3.61	-0.61
	(1.13)	(0.53)

Table 4.2: Average change in satisfaction induced by the restarted contest.
Note: Separated for winners and losers of the first and second contest. Standard errors in parentheses, grouped at the matching group level.

Comparing all four cases, we observe an intuitive ordering. Playing the second contest yields the largest increase in happiness for players who have lost before and win now ($\Delta s_{2,LW} = 3.61$), the reaction for players who win twice ($\Delta s_{2,WW} = 0.42$) is somewhat smaller, the reaction for players who lose twice is negative and small ($\Delta s_{2,LL} = -0.61$, which is not significantly different from the effect of winning two times in a row) and the happiness of players who have won before and lose now strongly decreases ($\Delta s_{2,WL} = -5.11$, which is more than half the available scale).

In line with our prediction, the satisfaction of winners increases and the satisfaction of losers decreases. Now let us check whether the intuition that the effects are larger if the outcome is a visually tight one holds true. In figure 4.1 we have separated the observations according to tight victories and losses on the one hand and sure victories and losses on the other hand. We classify an outcome as tight if the arrow on the fortune wheel determining the winner stopped within 18 degrees (i.e. 5% of the complete circle) towards the next border, and as a sure outcome if the arrow stopped further away from the next border.[16] The left panel depicts the bid differences,

[16] We get qualitatively the same results if the border is set to 20% (72 degrees) or at the median of the observations, except for the fact that in the latter case, the satisfaction increase for winners for which the arrow stopped closer to the border (1.1) is not larger than the satisfaction increase for winners for which the arrow stopped further away from the border (1.4).

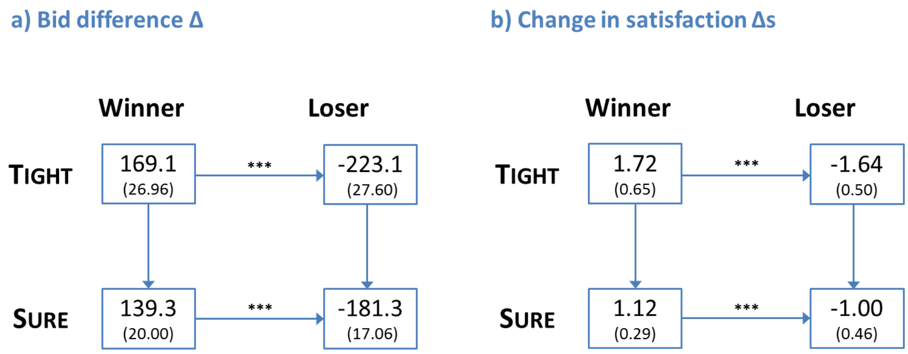

Figure 4.1: Bid difference (in panel a) and change in satisfaction (in panel b) for winners and losers, separated for tight victories (and losses) and sure victories (and losses).

Note: Standard errors in parentheses. 22 outcomes are classified as tight and 82 as sure.

which are positive for winners and negative for losers. Interestingly, the absolute value of this measure for the joy of winning and the frustration of losing is larger for tight outcomes (upper row) than for sure outcomes (lower row). The right panel depicts the change in satisfaction that is induced by the contest. Winner's satisfaction increases, while loser's satisfaction decreases, and in line with our intuition, the size of both of these effects is stronger for narrow outcomes than for what seemed to be sure outcomes. Our prediction that visually tight outcomes lead to stronger reactions is qualitatively confirmed for both joy of winning measures (bid difference and satisfaction), yet we can only find statistical support for this statement for the case of testing bid differences (p-value $= 0.08$, Mann Whitney U tests at the individual level on absolute values of bid differences, for winners and losers jointly).

Result 4.3 *If the arrow on the fortune wheel stops in close proximity to the border between both players' winning regions, differences of observed bids to predicted bids are significantly higher and changes in satisfaction are higher than in the case in which the arrow stops far away from such a border.*

Similar to the enhanced reaction when the arrow stops near the border between both winning regions, we expect that over- and underbidding as

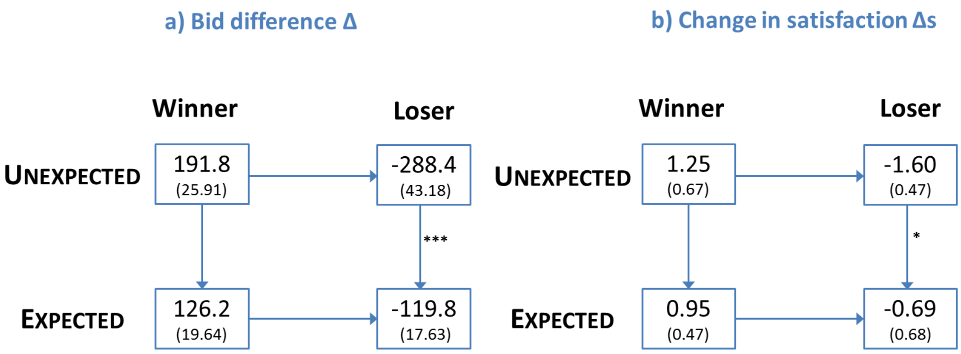

Figure 4.2: Bid difference (in panel a) and change in satisfaction (in panel b) for winners and losers, separated for unexpected victories (and losses) and expected victories (and losses).

Note: Standard errors in parentheses. 24 gains are classified as unexpected (with the rest of 28 gains as expected) and 20 losses are classified as unexpected (with the rest of 32 as expected).

well as changes in satisfaction are magnified when the outcome comes as a surprise. Therefore, figure 4.2 analyzes a specific subset of players for which winning (or losing) either comes as a surprise or is taken for granted, after both players have chosen their efforts and the winning probabilities are revealed. We assume that subjects whose winning probability is smaller than one third expect to lose and that for these subjects winning comes as a surprise. On the other hand, subjects with a winning probability larger than two thirds expect to win and for these subjects losing comes as a surprise.[17] The left panel of figure 4.2 depicts over- and underbidding for playing the contest again. We find that the magnitude of the joy of winning and of the frustration of losing is larger when winning or losing comes as a surprise, with the difference for losers being highly statistically significant (p-value < 0.01, Mann Whitney U test at the individual level). The right panel shows that unexpected winning or losing also leads to a stronger reaction in self-reported satisfaction, although the difference is only significant for losers (p-value $= 0.06$, tested at the individual level). As expected, the joy

[17] We get qualitatively the same results if we are working with more extreme probability values, but then the number of observations for the unexpected case drops further.

Correlation coefficient	Δ_i	Δs_i	x_i^0	$x_{i,old}$
Bid difference Δ_i	1.000			
Change in satisfaction Δs_i	0.42	1.000		
	(0.00)			
Effort in zero prize contest x_i^0	0.05	0.01	1.000	
	(0.61)	(0.90)		
Effort in former contest $x_{i,old}$	0.06	0.03	0.28	1.000
	(0.51)	(0.75)	(0.00)	

Table 4.3: Correlation between joy measures and effort.

Note: Spearman correlation coefficients between both joy of winning measures, effort in a zero prize contest and effort in the old contest. P-values in parentheses.

of winning is higher the lower the actual win probability of this player.

The different dimensions of the joy of winning might alternatively be investigated by a treatment variation with asymmetric players who differ in terms of their marginal costs of effort. Then, the favorite's win probability is higher ex ante and we might expect that ceteris paribus the favorite has a higher frustration from losing than the underdog and the underdog has a higher joy of winning than the favorite. However, we look at the most simple case of players with symmetric cost of effort whose role as favorite or underdog is only determined by their own effort choices.

We have two measures for the joy of winning, the bid difference and the change in self-reported satisfaction. Table 4.3 shows the Spearman correlation coefficient and the corresponding p-value between both measures. We see that bid differences are significantly positively correlated with the change in satisfaction.[18] Of course, we are also interested in the relation between our measure and the measure that has been used by other studies: effort in a zero-prize contest. The third row of table 4.3 shows that there is practically zero correlation between this measure and either of our

[18] However, if concentrating on the subset of winners or losers, we observe both measures to be significantly correlated only in the case of losers.

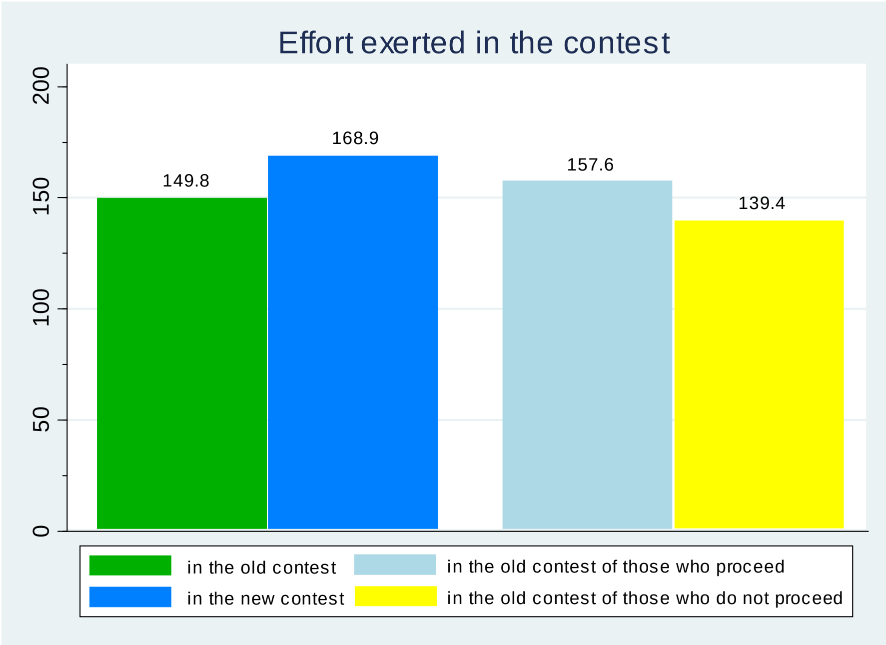

Figure 4.3: Average effort choices in the contest.

measures. Yet, as hypothesized in the introduction, the effort in this zero-prize contest is significantly positively correlated with the effort in the first contest against a human contestant (see the fourth row).[19] This speaks for the conjecture that (some) players just type in the same effort in both, zero-prize contests and valuable-prize contests. Interestingly, our joy of winning measures are uncorrelated with the average effort chosen in the former contest. Separating the data according to winner status, we find that the frustration of losing increases with effort in the former contest. In the next paragraph, we want to further investigate these effort choices.

Figure 4.3 shows the average effort of players in the first contest against a human contestant (first bar from the left) and in the second contest against a human contestant if there was a restart (second bar from the left). We find that effort in the restarted contest is significantly higher (p-value $<$ 0.01, Wilcoxon signed rank test at the matchinggroup level).

Result 4.4 *Average effort in the restarted contest is significantly higher than in the original contest.*

[19] In fact, we obtain a significantly positive correlation between effort in any contest of value V=500 and effort in a contest of value V=0.

The increase could be driven by two different effects:[20] Either it is due to selection which happens if a specific subset of people who tend to exert a lot of effort enters the second contest more often (because they bid more for replaying the contest). Or the effort increase is a strategic reaction, because players know that they are fighting against a specific subset of people (strategic) or because they have consciously chosen to replay the contest and are now very keen on winning (self-commitment). If the first (selection) effect is true, first contest effort by the players who proceed to play the second contest should be higher than first contest effort by the players who do not proceed to play the second contest. The two bars on the right side of figure 4.3 show that effort by players who continue is higher on average, but the difference between both types of players is only marginally statistically significant (p-value = 0.11). What about the second (strategic) effect? Does the effort level of those players who play both contests differ between the first and second contest? Concentrating on the second and third bar in the center of the figure, we see that effort for this subset of players is higher in the second contest and we find this difference to be statistically significant (p-value = 0.03).[21] Hence, we cannot firmly reject neither of the proposed explanations: The higher effort in the second contest can be explained by both, selection and strategic or commitment effects.

4.3.2 Regression analysis

To further test our predictions we proceed with a multivariate analysis. Table 4.4 presents the results of three sets of regressions.[22] In all estimations we control for whether each player was a winner in the previous contest. Moreover, we include socioeconomic information from the post-experimental

[20] Also see Herbst (2016a) for a more formal argument why we expect to see higher effort in the second contest.

[21] This result is also in line with a finding by Bradler et al. (2016) according to which recognition increases subsequent performance by the best performers. In our experiment, those subjects with the highest joy of winning are the "best performers" in the first contest, and the opportunity to play it again is some kind of recognition to which they react by increasing their effort levels.

[22] Table 4A.1 in Appendix 4.A.4 repeats estimations (1) to (4) using the full sample as we exclude three outliers in the first four estimations of table 4.4. The fit of these regressions deteriorates, but we still find that being a winner has a lot of explanatory power.

questionnaire and a number of individual-specific control variables generated in post-experimental tests. All regressions include "effort if V=0" which is the effort exerted in a zero-prize contest, “risk_general,” which is a self-reported measure for the willingness to take risk on an increasing scale from 0 to 10 and “risk_lottery,” which measures the number of investments in lotteries with different win probabilities (on a scale from 0 to 5). We control for efficiency-searching behavior in individual two-person allocation decisions, for loss aversion, ambiguity aversion, optimism, and pessimism. As socioeconomic variables we further include age, gender, field of study, semester, number of siblings, and the willingness to compete in daily life (deduced from their self-reported participation in a) lotteries, in b) card games and board games, and in c) sports contests or other types of contests).

The dependent variable in columns (1) and (2) is the bid b_i that players place for a restart. In line with the non-parametric tests we find that winners place a lower bid than losers. In column (2), "effort x_i" also controls for the effort expended in the contest.[23] We find that keeping the effort level constant, the influence of being a winner continues to be negative. We find that bids only increase by 0.3 points for every unit of effort exerted, although they should increase by 1 point (as independent of being a winner or a loser, the cost of effort in the former contest is completely reimbursed if a restart takes place).

The dependent variable in columns (3) and (4) is our first measure for the joy of winning. Hence, the left-hand side variable in these estimations is overbidding $\Delta_i = b_i + \pi_{i,old} - \frac{V}{4}$. We find that overbidding is much higher for winners than for losers, in line with result 4.1. In column (4), controlling for the effort expended we find the mirror image of column (2): As the observed bids underreact to effort, our overbidding measure is lower the higher effort is. Moreover, in all four regressions we find that bids or bid differences increase with “risk_lottery”. This measures the number of times a player invests in lotteries with different exogenous win probabilities

[23] Effort is closely related to payoff, but we cannot keep payoff constant when changing a subject’s status from loser to winner, therefore we decided to include effort.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable	bid for restart b_i		overbidding Δ_i		change in satisfaction Δs_i	
constant	91.6	53.8	-164.8**	-71.1	0.55	1.71
	(66.25)	(70.76)	(78.18)	(70.76)	(1.62)	(1.60)
winner	-113.7***	-131.1***	325.9***	368.9***	2.33***	2.82***
	(15.97)	(16.77)	(18.62)	(16.78)	(0.47)	(0.55)
effort x_i		0.29**		-0.71***		-0.01**
		(0.12)		(0.12)		(0.003)
effort if $V = 0$	0.01	-0.03	-0.13	-.0.03	-0.001	0.000
	(0.13)	(0.12)	(0.13)	(0.12)	(0.004)	(0.004)
risk_general	-3.94	-5.83	-10.5**	-5.83	0.08	0.14
	(5.18)	(4.85)	(4.78)	(4.85)	(0.15)	(0.15)
risk_lottery	27.1***	28.9***	33.5***	28.9***	-0.13	-0.16
	(8.09)	(8.42)	(11.38)	(8.42)	(0.32)	(0.33)
Socioeconomics	yes	yes	yes	yes	yes	yes
Obs	101	101	101	101	104	104
R^2	0.469	0.502	0.832	0.880	0.288	0.322

Table 4.4: Estimation results.

Note: Standard errors in parentheses, clustered at the individual level. Estimations (1) to (4) exclude three outliers who indicated in the post-experimental questionnaire that they had severe difficulties in understanding the bidding mechanism.

in the post-test, and thus measures some kind of risk loving together with being a control for the joy of playing a lottery. None of the other individual-specific characteristics that we obtained from our various post-tests and the questionnaire has explanatory power for any of our joy of winning measures. This also implies that loss aversion - which is one of the proposed explanations for overexpenditure in contests - cannot explain the results on bid differences for winners and losers in our framework.

In columns (5) and (6) the dependent variable is our second measure for the joy of winning, i.e. the change in self-reported satisfaction that is induced by playing the first contest against a human contestant. We find that the change in satisfaction is significantly more positive for winners than for losers, in line with result 4.2. Standard theory predicts that the ones with the highest payoff (winners) should exhibit the highest satisfaction. Therefore, as controlling for payoff directly would already pick up whether someone is a winner or a loser, we control for individual effort in column (6). With every unit of effort expended (controlling for being a winner or loser), the increase in satisfaction is 0.01 units smaller, i.e. player's satisfaction also depends on monetary outcomes. We do not think that monetary payoff is the only explanatory variable for satisfaction differences. Before, we have seen that the reactions to winning or losing are stronger in the restarted contest, although the monetary consequences are almost the same. Yet, if we wanted to change the status of a winner (to a loser) while keeping the payoff constant, we would need to run a further treatment in which losers earn 500 tokens and winners earn, e.g. 1000 tokens. Using this setup, we could check whether the satisfaction increase from gaining $500 - x$ tokens differs between winners and losers.

4.3.3 Discussion

We have presented evidence that winning in an experimental contest has additional consequences on top of the allocative ones: Winners are more satisfied than losers and when asked how much they are willing to pay in order to play again, they bid more than a theory model without such non-monetary utility effects would predict. In this section we want to shortly present other explanations that might exist for our observations.

The hot hand bias, a phenomenon first discussed by Gilovich et al. (1985),[24] suggests that winners believe to win with a higher likelihood when playing again. Therefore, they would overbid and losers would underbid. The gambler's fallacy, according to which random sequences exhibit systematic reversals, suggests that winning players believe to lose the next time. Therefore, they would underbid and losers overbid. Our data are more in line with the hot hand bias. Usually, this behavioral bias is applied to stochastic events, whereas in our case the players can influence their winning probability by choosing their effort levels and randomness is therefore reduced. Yet, as discussed above, we cannot determine whether differences in the expected payoff of a new contest come from different subjective valuations of the prize or different subjective probability evaluations.

Another caveat is that bids for a restart by both winners and losers exhibit some tendency towards zero. Thus, the results we obtain on the differences in bids (compared to the expected value of a restart) could at least also partly be explained "by construction". However, our data on the satisfaction measure for the joy of winning and the frustration of losing should be unaffected by any of the above mentioned biases (the hot hand, gambler's fallacy, and reversion to zero). Satisfaction differences confirm our results for the incentivized measure, but they can be explained by monetary considerations.

A further line of argument includes relative standing or status considerations, that is, players are better off in terms of utility when they are ahead of the other player. However, note that winning players in our experiment would then have no incentive to overbid for playing the contest again, as there is some probability of giving up the pole position in the next contest. In even starker contrast stands the behavior of losing players who should bid a lot for their chance of obtaining the pole position in the next contest if they are driven by relative standing considerations, but this is not what we observe.

An interesting treatment variation would be to analyze a proportional prize contest instead of a winner-takes-all contest. This alternative rule has

[24] See also Croson and Sundali (2005) who present evidence for a small bias in this direction and Rabin and Vayanos (2010) for a modeling approach.

also received attention in the literature. In such a contest, one pays out shares of the prize according to players' win probabilities. By paying out shares, expected payoffs stay the same, but realized payoffs change. In such an environment, we expect to see less of a joy of a winning or a frustration of losing if players always receive that part of the prize that they have a claim on by their winning probability.[25] Another treatment variation where we predict a null-result concerns the finding on visually tight outcomes. Here, an interesting placebo test would be to eliminate the arrow on the fortune wheel. Then, players do not take one outcome as tight and another one as sure anymore. On the other hand, we would expect all of our results to be stronger if winning is recognized even further by either giving out a nice certificate or publicly announcing victory.

4.4 Conclusion

Among the established results of human behavior in experimental lottery contests is the fact that players typically overexert effort and that effort levels are very heterogeneous across individuals. A common explanation is that there are heterogeneous perceptions of the prize value because for some players winning in itself is worth a lot, while others only care about the monetary value of the prize. With our experiment we aimed at providing evidence for the existence of such an individual-specific joy of winning in experimental contests. We do so by letting players bid for a restart of the contest, which eliminates the monetary payoffs from the former contest. We think that this chapter should be good news for all experimental economists and psychologists who work on contests and who claim that the joy of winning and its counterpart, the frustration of losing, can explain part of their data.

We find that players who have just won a contest bid much more than the monetary value of a restart for playing the contest again. Furthermore, players who have just lost a contest bid much less than the monetary value

[25] A similar prediction arises if we were to use a combination of an egalitarian sharing rule with a usual Tullock lottery contest. With this rule (see Nitzan 1991) player's own influence on winning is weakened and this might have an effect on the joy of winning and the frustration of losing.

of a restart for playing the contest again. We interpret this as evidence for the joy of winning and the frustration of losing. A second, non-incentivized measure confirms our findings: Self-reported emotional states on happiness or satisfaction increase for winners, but decrease for losers.

Effort in a zero-prize contest, a value that has been used to measure the joy of winning in the literature, is not correlated with our incentivized measure nor with our non-incentivized measure. Thus, this measure should be interpreted with caution. We have investigated differences in both of our measures a bit further and find that the effects are larger if the outcome comes unexpected and if it is illustrated as a tight outcome.

On average, effort in the restarted contest is higher than in the original contest. This is due to selection of high effort types, but also because these types increase their effort level even further after selecting into the contest a second time. The higher effort level also has implications for overall efficiency of the contest. Because of the higher level of effort expended, players who select into the restarted contest are on average worse off (in terms of payoff). They might be happy about winning the contest for the first time, but the happiness does not translate into their pockets.

4.A Appendix

4.A.1 Fortune wheel

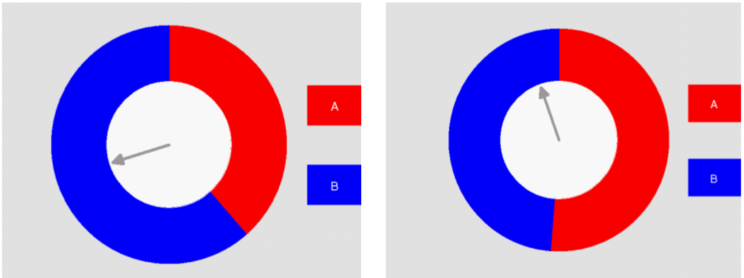

Figure 4A.1: Screenshots of fortune wheels.

Note: Depicted are two fortune wheels. The red part illustrates the winning probability of player A and the blue part illustrates the winning probability of player B. The arrow starts at the top, moves around and stops randomly. In both illustrations, player B wins. On the left hand side, the outcome seems to be a sure one as the arrow stops far away from a border, whereas on the right hand side, the outcome seems to be a tight one as the arrow stops close to a border.

4.A.2 Distribution of bids

Figure 4A.2: Histogram of the bids for a restart, separated for winners and losers.

4.A.3 Distribution of overbidding

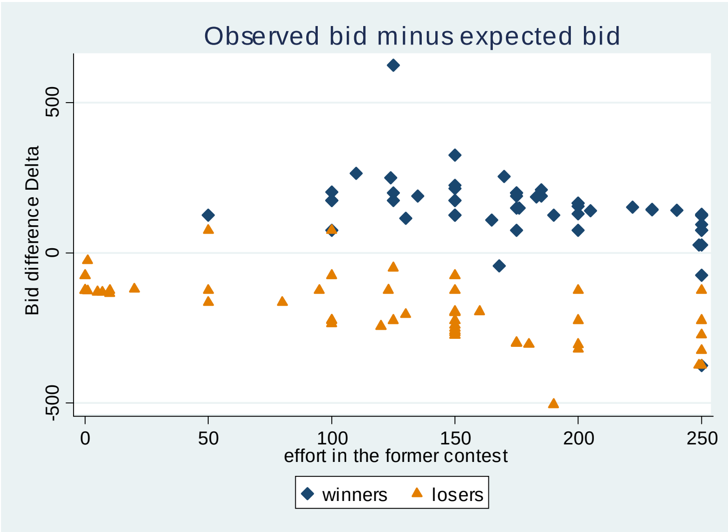

Figure 4A.3: Bid differences for winners and losers.

4.A.4 Robustness of regressions

	(1)	(2)	(3)	(4)
Dep. variable	bid for restart b_i		overbidding Δ_i	
constant	67.8	62.2	-196.3**	-62.8
	(84.77)	(89.15)	(98.66)	(89.15)
winner	-104.8***	-107.1***	337.0***	392.9***
	(23.12)	(27.06)	(27.38)	(27.06)
effort x_i		0.04		-0.96***
		(0.18)		(0.18)
effort if $V = 0$	0.12	-0.12	0.001	.0.12
	(0.15)	(0.16)	(0.16)	(0.16)
risk_general	-5.83	-6.12	-13.0**	-6.12
	(6.78)	(6.71)	(7.04)	(6.71)
risk_lottery	1.89	2.01	5.01	2.01
	(21.00)	(21.53)	(25.60)	(21.53)
Socioeconomics	yes	yes	yes	yes
Obs	104	104	104	104
R^2	0.303	0.303	0.717	0.793

Table 4A.1: Estimation results.

Note: Standard errors in parentheses, clustered at the individual level. The table reproduces estimations (1) to (4) of table 4.4 including all observations.

4.B Experimental instructions

This section contains a translation of the instructions handed out at the beginning of the experiment.

Welcome to this experiment! Please read the following instructions carefully and entirely. A precise understanding of the instructions can help you to gain more money.

Occasionally you might need to wait for the progress of the experiment. We kindly ask you not to eat, read or use your mobile phone during the experiment. Anything that distracts your attention from the experiment is prohibited. Please note that you are by no means allowed to communicate with other participants. If you violate any of these rules, you will be immediately excluded from the experiment without receiving any payment. If you have any questions please raise your hand. We will be happy to help you.

The experiment consists of several consecutive parts. Your decisions in one part do not impact any other part. In each part you can earn tokens with 50 tokens being equal one euro.

Part 1

What is it about? Your task is to count the digit zero in a numerical sequence. If your input is incorrect, you can enter your answer again. As soon as you have entered the correct number of zeros, new numerical sequences will be generated.

How many rounds are there? This task will be repeated 15 times. Thus, you have to answer 15 numerical sequences correctly.

What do I earn in part 1? In this part you earn 750 tokens, independent of the number of tries you need. Your earnings serve as your endowment for part 2.

Part 2

What is it about? After having successfully completed part 1, part 2 will start. In each round of the second part, two participants choose their "investment" simultaneously and independently. The two participants' investments influence their probability to receive 500 tokens for themselves in part 2. Every participant can choose any amount between 0 and 250 tokens as investment. The amount entered has to be paid to the laboratory.

How does one round proceed? After both participants have chosen their investment, they will see both investments on the screen. The investments affect which of the two participants will receive the 500 tokens. One participant's probability of success, i.e. the probability that this participant receives the 500 tokens, corresponds to the proportion in his invested tokens on the total amount of tokens invested by him and the other participant. The following applies:

$$\text{Success probability} = \frac{\text{own investment}}{\text{own investment} + \text{the other participant's investment}}.$$

Therefore, the participant who invests more will not automatically receive the 500 tokens. The more tokens a participant invests, however, the more likely he will receive the 500 tokens. Obviously, he then has to pay more tokens to the laboratory. If in one round both participants decide to invest 0 tokens, the probability of success for both participants will be 50%.

The probabilities of success will be shown on the screen as a pie chart, which is divided into two colors. The division arises proportionally out of the two participants' invested tokens. A pointer will rotate slowly on the circular area and randomly stop at one point of the circle. The greater one participant's probability of success, the bigger is his area within the circle and the more likely the pointer will stop in his area. Hence, depending on the area in which the pointer stops, participant 1 or 2 will receive the 500 tokens.

How many rounds are there? The procedure described above under part 2 will be repeated several times. During rounds 1-4, the investment of your co-player will be generated automatically by the computer. This investment of the co-player corresponds to the typical behavior of other participants in the past. The first four rounds will not be paid out. They will help you, however, to gather some experience within the decision-making situation in part 2. After that you will play against another participant of this experiment. For that, the computer will randomly form groups of two. You will not know who your paired participant is.

What do I earn in part 2? Only one round will be paid out in part 2. With your decisions you affect which round will be paid. If you win in the round that is relevant for your payment, you will gain 500 tokens minus your investment in tokens. If instead your player wins, you will have to pay your investment and you will not receive any further payment. That means that you have to pay your investment regardless of receiving the 500 tokens or not.

Part 3 Information about part 3 will appear on the screen at the appropriate time. In this part, all of the participants run through the same 11 scenarios, from which one relevant for payment.

Summary At the end of today's experiment, your revenues from all parts of the experiment are added up and converted into euros. In addition, you will receive a show-up fee of 6 euros. In any case the total amount of euros will be positive. You will receive your money in cash from the laboratory.

What else should I consider? Before the experiment starts, questions about the process of the experiment are going to appear on the screen. These questions clarify the rules of the experiment by means of examples. Furthermore, we will ask you for some more information during the experiment as well as afterwards; of course all your information is used anonymously. If there is a health-related or technical emergency during the experiment, please press the F1 button.

Thank you for coming. Good luck for the experiment!

Chapter 5

On the self-selection of happy winners

5.1 Introduction

Situations that can be modelled as a contest are ubiquitous in the real world. The contest framework can be used to describe settings as diverse as military battles, sports competitions, innovation races in research and development, or promotions in the workplace. The analysis of lottery contests in the laboratory and of human decision behavior in these situations has shown that contest participants typically exert too much effort as opposed to the Nash equilibrium. One of the explanations for this phenomenon is the joy of winning: Players overbid because the winner does not only receive the monetary value of the prize, but also some non-monetary component stemming from the fact that he leaves the battlefield as the winner. In the economics literature, the existence of a joy of winning is increasingly accepted.[1] Studying the joy of winning is also interesting because it could be a possible rationalization of irrational behavior such as gambling addictions. In this chapter, we introduce the joy of winning into a contest model and analyze its implications for selection and effort. The research questions we address are the following: If a contest designer is interested

[1] It has also entered other sciences, e.g. according to a recent study in media studies by Albarán-Torres (2016), the joy of winning is one of the benefits that keeps users of mobile gaming apps playing.

in maximizing the average effort in the contest, should he allow the players to choose between terminating or restarting the contest? What does the joy of winning imply for the self-selection of players into the restarted contest? Furthermore, what is the effect of the choice to opt for a restart on aggregate effort?

The contest designer typically faces few restrictions when deciding on the rules of the game. Sometimes, the designer even changes the rules unexpectedly after the start of the contest. For example, he can decide to increase the prize money in the course of the contest, in order to increase the effort exerted by the contestants, as happened with the strong tether challenge (a component for a space elevator). However, this inducement prize contest was closed in 2011 without declaring a winner.[2] Similarly, the organizers of the Qualcomm Tricorder XPRIZE (aiming at developing a new instrument for health diagnosis) decided to extend the contest only after picking the finalists, adding a new consumer testing phase. This gives finalists time to refine their instruments, but also means that they have to compete against the other participating teams once more.[3] Whereas the Qualcomm Tricorder XPRIZE does not allow for new entrants at the current requalifying round, in the longitude prize (whose aim is to develop a quick, simple, exact and cheap test for bacterial infection), contestants can (re-)enter at any time until the committee (the contest designer) agrees that one team has fully met the requirements and is awarded the prize. Thus, the possibility to re-enter a contest is not uncommon.

Restarts of a contest also occur in sports tournaments. There are a couple of examples of revenge matches between boxers or wrestlers or of rematches between chess players.[4] For these, the contestants themselves mostly decide about going for a restart or not. Therefore, they might already have the possibility of a restart in mind when deciding on their effort in the first match. At other times, contestants do not expect a restart when they fight the original contest. A famous example in football history is

[2] See http://www.spaceward.org/games-st and https://herox.com/news/150-the-nasa-centennial-challenge-program.

[3] See http://tricorder.xprize.org/about/schedule.

[4] Indeed, there is a lively discussion on the advantages and disadvantages and the right way of offering or declining rematches on the forum of www.chess.com.

from November 1904 when Everton travelled to play against Arsenal. With Everton leading 3-1 in the 75th minute, heavy fog forced play to stop. A full replay was scheduled, and in April 1905 Everton lost the match 2-1. Also today, weather phenomena such as heavy rain can lead to the abandonment of a match and uncertainty about whether there is a restart. Sometimes, an abandoned game is not replayed at all (as in the case of Brisbane vs. Wellington in March 2015)[5], other times, the full game is replayed (as in the case of Nice vs. Nantes in October 2015)[6]. It is up to the league officials (who design the contest) to decide on whether there is a replay in such a situation. There are also rare occurrences which are more unexpected than rain. For example, a deep hole on the pitch made it impossible to finish a rugby match between Bristol and Aberavon in the British & Irish Cup in October 2013.[7] Mistakes by the referee or attacks against the referee also have made it necessary to replay full matches or part of the matches.[8] A peculiar case was the match of Osnabrueck vs. Leipzig in August 2015 in the German football cup. The match was abandoned when an Osnabrueck fan threw a lighter at the referee in the second half with Osnabrueck (the underdog) leading 1-0. Although Leipzig offered to have a replay and published an official statement, thereby expending effort to bias the decision in favour of a restart, the football court decided to declare Leipzig the winner in this game without a replay.[9]

This type of discretion by the contest designer in deciding about the setup of the contest was also made use of in the laboratory experiment of chapter 4 in which we measure the individual-specific joy of winning and frustration of losing. In the experiment, subjects play a contest once, learn the outcome, and afterwards are told that they can place a bid to play

[5] See http://www.theroar.com.au/2015/03/23/roar-fury-shows-ffa-need-to-look-at-abandoned-match-policy.

[6] See http://www.ligue1.com/ligue1/article/nice-versus-nantes-rained-off.htm#.

[7] See http://www.bbc.com/sport/rugby-union/24673049.

[8] This happened to Uzbekistan vs. Bahrain in 2005, and to the female U19 competition between England and Norway in 2015, see https://www.theguardian.com/football/2015/apr/09/england-women-u19-replay-norway-referee-penalty-howler.

[9] See http://www.zdfsport.de/kein-wiederholungsspiel-das-sportgericht-des-deutschen-fussball-bundes-hat-die-abgebrochene-erstrundenpartie-im-dfb-pokal-zwischen-dem-vfl-osnabrueck-und-rb-leipzig-mit-20-fuer-leipzig-gewertet.-39709014.html.

the contest again or they will receive the payoff from the first contest. If the contest is restarted, the payoff from the first contest is not paid out, but instead the payoff is determined by the decisions concerning the second contest. The larger the bid that players place, the more likely they are to replay the contest. In the experiment we find that effort levels are higher in the second, restarted contest.

A possible behavioral explanation for the increase in effort could be the following: The players have consciously chosen to replay the contest and are now very keen on winning. This type of self-commitment leads them to increase their effort level. Having said that, there could also be another explanation that does not rely on behavioral reasoning and just makes use of the different subjective prize values due to differences in the joy of winning: Selection into the contest along the joy of winning. The intuition is that players with a high joy of winning select themselves into the restarted contest and those who care less about winning are less likely to end up in the restarted contest. Selection entails a number of effects: If the players with a high joy of winning also expend more effort, selection of these players into the contest leads to an increase in effort. Moreover, as the composition in the restarted contest is also more homogeneous (because when the distribution of players moves away from an equal distribution, there are always going to be more pairs with homogeneous contestants), there is a further positive effect on expected effort. However, there is also a confounding effect: Joyful players exert more effort and are therefore more likely to win the first contest. Hence, they might on average be less willing to go for a second round than the players without a joy of winning who are more likely to lose in the first contest and might therefore be more willing to go for a second round. This paper analyzes the countervailing effects and checks whether the effort increase observed in the experiment can be explained by selection.

Our analysis shows that a contest designer can benefit from allowing for a restart of the contest. In a model with two types, one type who cares only about the monetary value of the prize and the other type who might experience the joy of winning, effort levels are higher for joyful players. Joyful players care about winning in every separate contest, not just in the final payoff-relevant one. Moreover, we assume that there is asymmetric awareness between contestants and the contest designer about the stages. Despite the fact that the contestants might know that the unlikely event of a restart might occur, I make the simplifying assumption that contestants are somewhat naive and ignore this possibility when deciding on their first period effort. Besides enhancing the tractability of my model, I believe this simplification is not unrealistic in light of the above applications.

In our model, joyful players include the expected joy of winning in the expected payoff of a restarted contest. Despite the fact that joyful players prefer the contest population to be biased towards normal types, their bids for a restart of the contest are higher than the bids by players who care only about the monetary value of the prize. Therefore, more of the joyful types than of the types without a joy of winning end up in the restarted contest. We show that sorting along the joy of winning leads to an increase in average effort, which is beneficial for a contest designer who wants to maximize average effort. We also discuss the flip side of the coin: alternative setups in which players suffer from the frustration of losing, or in which both non-monetary components exist.

This paper is related to the growing literature on the joy of winning. How the joy of winning influences experimental results and how it is incorporated into theoretical models is shortly surveyed in the introductory section of chapter 4. The focus of the current chapter is on the difference between effort levels in an original and a restarted contest. Therefore, it is broadly related to some recent contest experiments that analyze effort decisions in repeated contests. Descamps et al. (2016) study real effort in dynamic lottery contests in the laboratory. They find no strategic momentum effect (according to which victory generates additional momentum for leaders and defeated opponents are discouraged). Rather, players in their experiment increase their effort after losing. Likewise, in an all-pay auction framework, Hart et al. (2015) find that after winning the contest, players in their experiment tend to invest less in the following round.[10] Johnson and Salmon

[10] Ernst and Thöni (2013) and Klose and Sheremeta (2012) also study all-pay auctions. They use the framework of prospect theory according to which participants enjoy gaining some amount of money more than losing the same amount of money. This helps them explain bimodal bidding behavior in their experimental auctions.

(2016) focus on how losers of promotion tournaments react to the outcome of the contest. They find that it depends on the specific promotion mechanism and on a player's ability whether effort on a later task increases or decreases. In all of these papers, there is no self-selection of players into the repeated contest.

In our model, the self-selection of players drives the increase. Therefore, the paper also touches upon the issue of entry into contests. Entry has been studied in a number of papers (e.g., Cason et al. 2010, Morgan et al. 2012 and Morgan et al. 2016). However, in these papers the outside option is typically a piece rate payment or another contest, whereas we consider the choice between staying with the first contest outcome or repeating the contest. Concerning entry decisions, Cason et al. (2010) show that in a real effort experiment, a proportional prize contest elicits more entry than a winner-take-all contest (which we study in this paper). Moreover, they show that weaker subjects tend to shy away from the winner-take-all contest. Morgan et al. (2012) also study entry into contest experiments, with six players staying in fixed groups for 50 periods. Their analysis predicts that self-selection of a similar type would lead to more homogenous effort spending. Yet, they find no trend in the dispersion of efforts over time, i.e. they find no evidence for more homogenous effort spending. Morgan et al. (2016) use the same matching procedure (six players, fixed in groups for 50 periods) to study entry into proportional-prize and winner-take-all contests, changing also the (risk of the) outside option. They find excess entry and excess bidding in all treatments. The authors introduce loss aversion and the joy of winning into their model to explain their results. We build solely on the joy of winning to explain entry decisions into the restarted contest as well as increased effort in the restarted contest.

In the next Section we introduce the model framework. We analyze the model in Section 5.3, discuss the driving forces of the results in Section 5.4 and provide concluding remarks in Section 5.5.

5.2 Theoretical framework

5.2.1 Model

The contest designer has the choice between a single one-shot Tullock lottery contest or an extended game with a surprise stage after the end of the first contest. If the designer decides to allow for a restart, the model consists of two consecutive games. When the players make their decisions in the first game, they are unaware of the existence of the second game. Nevertheless, both games are connected via the payoff function. Therefore, we will talk about a three stage game below. The first stage comprises game one and the second game encompasses stages two and three. The structure of the model follows the experimental set-up of Herbst (2016b) in which the subjects also only learn about the subsequent stages after completing the first game.

Stage 1: Contest

There is a continuum of individuals with mass 1. Out of these, two players A and B fight for a prize of monetary value V in a Tullock lottery contest. There are two types of individuals, $T = \{N,\ F\}$, i.e. we have a binary distribution of types. The probability of N-types in the population is 1/2 and consequently the probability of F-types in the population is also 1/2. For "normal" N-types winning a contest is worth V, but for joyful F-types winning yields some additional "fun" and thus winning a contest is worth $V + \Delta$.[11] As the joy of winning is valuable for the player, we assume that $0 < \Delta \leq V$, i.e. the non-monetary value of winning is positive and at most as large as the monetary value of winning. Although the analysis does not rely on Δ being not larger than the monetary value of winning, we want to limit its influence.

In the first stage, players are randomly matched into pairs. After the matching, both players in a pair learn their opponent's type. Knowing their own and their adversary's type, both players simultaneously choose effort x_i, $i = \{A,\ B\}$, i.e. we analyze a situation of imperfect information. The unit cost of effort is assumed to be constant and equal to one. Effort influences a

[11] This is a simple and extreme version of a model with two types, one type with a high joy of winning and another type with a low joy of winning.

player's winning probability pr_i, with the winning probability[12] being equal to the share of expenditure of contestant i to total expenditure:

$$pr_i(x_A, x_B) = \frac{x_i}{x_A + x_B}, \ \ i = \{A, B\}$$

if $x_A + x_B > 0$ and equal to 1/2 otherwise. Player i's expected payoff depends on his type with

$$E\pi_i(x_i) = \begin{cases} pr_i(x_A, x_B)V - x_i & \text{for an N-type} \\ \\ pr_i(x_A, x_B)(V + \Delta) - x_i & \text{for an F-type} \end{cases}, \ \ i = \{A, B\}$$

that is, i's expected payoff is equal to his probability of winning multiplied by the subjective prize (which is either only the monetary value or includes also the non-monetary component), minus the effort cost. Both types of players choose their effort level x_i to maximize their expected payoff in this stage. If the designer decides in favor of the simple setup, the first stage is the only stage of the game. Otherwise, the game continues to stage 2.

Stage 2: Bidding for a restart

Information on the existence and the modalities of the second game is revealed only after the first game (the first contest) is finished.[13] All players are randomly rematched into new pairs. In a specific pair, they again learn the type $T = \{N, F\}$ of the other player, i.e., whether the opponent is a normal type or a type for whom winning yields additional fun.

In the second stage, both players can bid $b_i \in [-V, V]$, $i = \{A, B\}$, for a restart of the contest. If the sum of these bids is positive, i. e. if $b_A + b_B > 0$, the game is restarted and the monetary payoff (including the cost of effort) of the former contest is cancelled. Otherwise, if $b_A + b_B \leqslant 0$, the outcome of the former contest is paid out and the players do not enter into the second contest.[14] In any case, strictly following the experimental

[12] The winning probability is denoted by $pr_i()$ in this framework, so that it shall not be confused with later continuation probabilities that are denoted by the letter p only.

[13] See Cohen and Sela (2005) for a theoretical analysis when the effort of the winner is reimbursed (and players know about this beforehand). Cohen and Shavit (2012) also run an experiment with refunds for the winner which leads to higher average bids.

[14] Alternatively, one could assume that the contest is also restarted if $b_A + b_B = 0$.

setup of Herbst (2016b), only the pivotal player in the decision for or against a restart actually pays a bid in the second stage and the absolute value of this bid is determined by the second-highest bid. Formally, final payoff Π_i will be

$$\Pi_i = \begin{cases} \pi_{i,new} + b_{-i} & \text{if } b_i > 0 \wedge b_{-i} \leqslant 0 \wedge b_i + b_{-i} > 0 \\ \pi_{i,new} & \text{if } (b_i > 0 \wedge b_{-i} > 0) \vee (b_i \leqslant 0 \wedge b_{-i} > 0 \wedge b_i + b_{-i} > 0) \\ \pi_{i,old} & \text{if } (b_i > 0 \wedge b_{-i} \leqslant 0 \wedge b_i + b_{-i} \leqslant 0) \vee (b_i \leqslant 0 \wedge b_{-i} \leqslant 0) \\ \pi_{i,old} + b_{-i} & \text{if } b_i \leqslant 0 \wedge b_{-i} > 0 \wedge b_i + b_{-i} \leqslant 0 \end{cases}$$

The payoff-structure can therefore be expressed as follows: If one player is willing to pay a fee for the restart and the other is not and if at the same time the sum of bids is positive, the restart takes place. The player who is willing to pay money for a restart (think about him as the loser of the first round) pays as much money to the mechanism as demanded by the other player (compare line 1), while the other player (which will be the winner in this example) does not receive or pay anything (compare line 2, second condition). If both players are willing to pay a fee for the restart, the restart takes place and no one pays a fee (compare line 2, first condition). Similarly, if both players are willing to pay a fee not to restart, the restart does not take place and no one pays a fee (compare line 3, second condition). If one player is willing to pay a fee for the restart and the other is not and if at the same time the sum of bids is non-positive, the restart does not take place. The player who is willing to pay a fee not to restart (think about him as the winner of the first round) pays as much money to the mechanism as the other player placed as a bid (compare line 4), while the other player (which will be the loser in this example) does not receive or pay anything (compare line 3, first condition).

The bids for a restart depend on the expected payoff from the new contest (which depends on own type and opponent's type) and on the realized

This would not change any lemma or proposition.

monetary payoff from the first stage (also type and co-type dependent). This describes the link of the first and second stage, as the payoff from the first contest (the first game) is taken into account when decisions in the second stage are made.

Stage 3: Restarted contest

Stage 3 is the final stage of the game and resembles stage 1. If the sum of bids by a pair in stage 2 is positive, the two players of this pair continue to stage 3. They then choose their effort to maximize their expected payoff from a Tullock lottery contest, as described in section 5.2.1.

5.3 Analysis

We begin by analyzing the first stage. We describe the equilibrium and compute effort as well as (expected and realized) payoff for the different pairs. As players are unaware of the subsequent stages when they decide on their first stage efforts, they believe that the first stage is the only stage of the game. Therefore, the analysis is the same for the first and third stage. Using the results from the first stage we show that comparing pairs with only F-types to pairs with only N-types, pairs with two joyful types are more likely to continue to restart the contest than pairs with two normal types. This is sufficient to show that generally more F-types than N-types continue, taking mixed pairs into account. Then we can show that the probability of a new match of two F-types is larger than the probability of a new match of two N-types. Finally, we use the general aggregate effort formula to show that the restarted contest (in stage 3) elicits more effort than the original contest (in stage 1).

5.3.1 Equilibria of stage 1

The equilibria of the stage 1 and stage 3 game are derived in appendix 5.A.1. Because of our unusual assumption that information on the second part is only revealed after the first stage is finished, the game under analysis is the same in both stages. Individual equilibrium effort levels $x_{i,TS}$ depend on own type $T = \{N,\ F\}$ and co-player's type $S = \{N,\ F\}$. We find that equilibrium efforts are $x^*_{i,NN} = \frac{V}{4}$ for a normal type against another normal type, $x^*_{i,FF} = \frac{V+\Delta}{4}$ for a fun-type against another fun-type, $x^*_{i,NF} = \frac{V^2(V+\Delta)}{(2V+\Delta)^2}$ for a normal type against a fun-type and $x^*_{i,FN} = \frac{V(V+\Delta)^2}{(2V+\Delta)^2}$ for a fun-type against a normal type. As expected, a joyful F-type invests more than a normal N-type, and the effort expended in a "pure pair" (against a co-player of the same type) is larger than the effort expended in a mixed pair (against a co-player of a different type): $x^*_{i,FF} > x^*_{i,FN} > x^*_{i,NN} > x^*_{i,NF}$.

Generally, aggregate average effort X in this stage is

$$X = rx^*_{NN} + qx^*_{FF} + (1 - r - q)\,\frac{x^*_{NF} + x^*_{FN}}{2},$$

where r is the probability of two N-types being matched into a pair, q is the probability of two F-types being matched into a pair and hence $(1 - q - r)$ is the probability of a mixed pair with one normal and one joyful type. Using the equilibrium efforts from above we get

$$X = \frac{1}{4\,(2V + \Delta)}\left[2V^2 + (2 + q - r)\,V\Delta + q\Delta^2\right]. \tag{5.1}$$

Aggregate effort rises with the percentage of pure F-pairs (q) and decreases with the percentage of pure N-pairs (r).

5.3.2 Continuation probabilities of pure pairs

For the second stage, there exists an equilibrium in weakly dominant strategies in which both players bid their true value of a restart, i.e.

$$b_i = \begin{cases} E\pi_{i,new} - \pi_{i,old} & \text{for an N-type} \\ \\ E\pi_{i,new} - (\pi_{i,old} - \Delta) & \text{for an F-type} \end{cases}, \quad i = \{A, B\} \tag{5.2}$$

Equivalently, we could assume that players do not behave strategically in this stage and only think about their own payoff. In any case, players bid the expected payoff from the restarted contest, $E\pi_{i,new}$, minus the monetary payoff from the old contest that will be cancelled if the second contest is played. The joy of winning as a non-monetary component cannot be cancelled. Instead, it remains with the joyful winner. With this in mind, we analyze under which circumstances the sum of bids by a pair of two N-types in the bidding stage will be positive so that this pair continues to the restarted contest and under which circumstances the same is true for a pair of two F-types.

Lemma 5.1 *The probability that a pair of two normal types ends up in the restarted contest is lower than the probability that a pair of two joyful types ends up in the restarted contest.*

Proof. Of the N-N pairs, only the combinations with both players having lost in the previous contest continue (see appendix 5.A.2). The likelihood for a matching of two losing N-types is $\frac{1}{2^6}$ for both losers against N, $\frac{(V+\Delta)^2}{2^4(2V+\Delta)^2}$ for both losers against F and $\frac{V+\Delta}{2^4(2V+\Delta)}$ for one loser against N and one loser against F.[15] Of the F-F pairs, the sum of bids is positive if both players had been losers in the previous contest and is also positive if only one of the players had been a loser. The likelihood for the different cases is $\frac{V^2}{2^4(2V+\Delta)^2}$ for both losers against N, $\frac{1}{2^6}$ for both losers against F, $\frac{V}{2^4(2V+\Delta)}$ for one loser against N and one loser against F, $\frac{1}{2^5}$ for one winner against F and one loser against F, $\frac{V}{2^4(2V+\Delta)}$ for one winner against F and one loser against N, $\frac{V+\Delta}{2^4(2V+\Delta)}$ for one winner against N and one loser against F and $\frac{V(V+\Delta)}{2^3(2V+\Delta)^2}$ for one winner against N and one loser against N. Taking all these expressions together, the following mass of N-N pairs continues:

$$P\left(NN \text{ cont.}\right) = p_N = \frac{1}{2^4\left(2V+\Delta\right)^2}\left[4V^2 + 6V\Delta + \frac{9}{4}\Delta^2\right]. \qquad (5.3)$$

[15] To arrive at this expression, think about an N-type who faced another N-type and lost against this N-type ($\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}$) being matched with an N-type who faced an F-type and lost against this F-type ($\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{V+\Delta}{2V+\Delta}$). Therefore, the probability of such a match is $\frac{1}{2^5}\frac{V+\Delta}{2V+\Delta}$. We also have the mirror case of an N-type who lost against an F-type being matched with an N-type who lost against an N-type. In total, the probability to see a match of two N-types of which one has lost against N and one has lost against F is therefore $\frac{1}{2^5}\frac{V+\Delta}{2V+\Delta} + \frac{1}{2^5}\frac{V+\Delta}{2V+\Delta} = \frac{1}{2^4}\frac{V+\Delta}{2V+\Delta}$. The other terms follow the same logic.

Of the F-F pairs, the mass that continues amounts to

$$P\left(FF \text{ cont.}\right) = p_F = \frac{1}{2^4\left(2V+\Delta\right)^2}\left[12V^2 + 10V\Delta + \frac{7}{4}\Delta^2\right]. \qquad (5.4)$$

Comparing $P\left(NN \text{ cont.}\right)$ as given by (5.3) with $P\left(FF \text{ cont.}\right)$ as given by (5.4) reduces to comparing the terms in squared brackets. Since $12V^2 + 10V\Delta + \frac{7}{4}\Delta^2 - \left(4V^2 + 6V\Delta + \frac{9}{4}\Delta^2\right) = 8V^2 + 4V\Delta - \frac{1}{2}\Delta^2$ is always strictly positive (because $V \geq \Delta$) we have shown that more of the F-F pairs continue than of the N-N pairs.[16] ■

Intuitively, think about all cases in which a loser is paired up with another loser. Whenever this occurs, the sum of bids is positive since the expected payoff from the new contest is positive and the eliminated monetary payoff from the old contest is negative. Hence, we only need to compute the sum of bids for pairs of two winners and for pairs with one winner and one loser. The computations in appendix 5.A.2 show that of the pairs with two N-types, only the pairs with two losers continue. If one of the N-types has won against another N-type before and the other N-type has lost against another N-type, the sum of bids is equal to zero, in all other pairs of one winning N-type and one losing N-type, the sum of bids is negative.

In the realm of pairs with two F-types, the pairs with two losers continue, but also all pairs with one loser and one winner. Remember that when players reach the third stage with the restarted contest, only the monetary payoffs from the first contest are cancelled, i.e. the joy of winning Δ for winning F-types is not affected.[17] Thinking about possible opponents in the restarted contest, F-types would rather not face other F-types because their expected payoff against an F-type is lower than against an N-type. This

[16] In fact, the above inequality is true as long as $\Delta < \frac{4V}{\sqrt{2}-1} \approx 9.66V$. However, once Δ increases in relation to V, also the sum of bids by two winning F-type players may become positive and hence, the probability of a pair of two F-types continuing increases, while the probability of a pair of two N-types continuing stays the same. Hence, the result in lemma 5.1 continues to hold when Δ is larger than V.

[17] The profit that will be cancelled depends on the adversaries' type in the former contest and is $\pi_{i,W}\left(x^*_{i,FF}\right) = \frac{1}{4}\left(3V - \Delta\right)$ for a F-type who has won against another F-type and $\pi_{i,W}\left(x^*_{i,FN}\right) = \frac{V\left(3V^2+2V\Delta\right)}{(2V+\Delta)^2}$ for a F-type who has won against an N-type.

lowers their bid for a restart.[18] However, since their expected payoff from the restarted contest includes the expected joy of winning, bids by winning F-types are larger. The latter effect dominates the former so that bids by F-types are higher than bids by N-types and therefore one loser in a pair is enough to generate a positive sum of bids. Taking the likelihood of the combinations under analysis into account, we find that more of the pairs of only F-types continue than of the pairs of only N-types.

5.3.3 Composition in the restarted contest

In order to make a statement on the aggregate effort in stage 3 (the restarted contest) compared to stage 1 (the original contest), we need to know more about the percentage of pure F-pairings (q) and the percentage of pure N-pairings (r) in the restarted contest.

Lemma 5.2 *The probability of an F-type meeting an F-type in stage 3 is higher than the probability of an N-type meeting an N-type.*

Proof. Call the probability of a mixed pair that joins the restarted contest p_M, then the probability of meeting an F-type in stage 3 is $\frac{p_F+p_M}{p_F+2p_M+p_N}$ and the probability of meeting an N-type in stage 3 is $\frac{p_N+p_M}{p_F+2p_M+p_N}$, where p_N and p_F are given by (5.3) and (5.4), respectively. From these expressions, we can directly compute the probability q^{new} of an F-F combination in the restarted contest and the probability r^{new} of an N-N combination in the restarted contest. From $p_F > p_N$ it follows that

$$q^{new} = \left(\frac{p_F + p_M}{p_F + 2p_M + p_N}\right)^2 > \left(\frac{p_N + p_M}{p_F + 2p_M + p_N}\right)^2 = r^{new}$$

■

These probabilities include the members of mixed pairs (with one F-type and one N-type) who enter the restarted contest. Recall that whenever

[18] This effect cannot be directly seen in the analysis as it compares pairs of two F-players with mixed pairs and the sum of bids for such mixed pairs is irrelevant for our line of argument. However, it is clear from the expected payoffs in appendix 5.A.1 that F-types expect a higher payoff against N-types than against F-types. Moreover, the difference in payoffs comparing playing against N-types or against F-types is larger for F-types than for N-types (for whom the effect also occurs, but less pronounced).

a mixed pair continues, one F-type continues and one N-type continues. Because more of the pure F-pairs continue than of the pure N-pairs, more joyful types than normal types continue and there will be more pairs of only joyful types than pairs of only normal types.

5.3.4 Effort in the restarted contest

The information we gathered on the composition in the restarted contest is necessary to arrive at our main proposition.

Proposition 5.1 *Suppose that selection into the contest follows the rules described above. Then, the average effort exerted in the restarted contest is higher than the average effort exerted in the original contest.*

Proof. Aggregate effort is $X = \frac{1}{4(2V+\Delta)}[2V^2 + (2+q-r)\,V\Delta + q\Delta^2]$. In stage 1, using $q^{old} = r^{old} = \frac{1}{4}$, we have $X_{old} = \frac{1}{4(2V+\Delta)}\left[2V^2 + 2V\Delta + \frac{\Delta^2}{4}\right]$. The term multiplying the term in squared brackets remains unchanged with changes in the population distribution. The only terms that change with the distribution are $(2+q-r)\,V\Delta$ and $q\Delta^2$. Since $q^{old} = r^{old}$, the term in round brackets multiplying $V\Delta$ is equal to 2 in stage 1. However, in the restarted contest there are more joyful pairs than normal pairs, i.e. $q^{new} > r^{new}$. Hence, $(2 + q^{new} - r^{new}) > 2$, i.e. the multiplier of $V\Delta$ is larger in the restarted contest . It remains to analyze what the selection implies for $q\Delta^2$. In fact, we can show (see appendix 5.A.3) that the probability of a pair of two joyful types in the restarted contest will be larger than in the original contest, or expressed formally: $q^{new} > \frac{1}{4}$, the probability of pure F-pairs in stage 1. This completes the proof. ■

The selection leads the contestant population to be biased towards F-types. This has two implications for effort: Generally, effort by F-types is higher than effort by N-types. Moreover, effort by F-types is higher against F-types than against N-types. Hence, aggregate effort goes up. Therefore, a contest designer who is interested in maximizing average effort in the contest can compare the aggregate effort in the first stage (from a simple game without a restart) to the average effort in the third stage (when he allows for a restart). He observes that average effort is higher in the extended version of the game, so he should opt to allow for a self-selection of players.

The contest designer could also pursue a different goal, for example maximizing total effort in all final matches. Such a designer would have to compare average effort in the second contest with average effort of those first contest games that are cancelled. From the above analysis we know that the composition in the restarted contest is biased towards joyful F-types. Hence, the probability of a pair of two F-types in the restarted contest is $q^{new} = \left(\frac{1}{2}+\varepsilon\right)\left(\frac{1}{2}+\varepsilon\right)$, where $\varepsilon > 0$, whereas the probability of a cancelled match of two F-types is $q^{cancelled} = \frac{1}{2}\left(\frac{1}{2}+\varepsilon\right)$, hence $q^{new} > q^{cancelled}$. Moreover, the probability of a pair of two N-types in the restarted contest is $r^{new} = \left(\frac{1}{2}-\varepsilon\right)\left(\frac{1}{2}-\varepsilon\right)$, whereas the probability of a cancelled match of two N-types is $r^{cancelled} = \frac{1}{2}\left(\frac{1}{2}-\varepsilon\right)$, hence $r^{new} < r^{cancelled}$. From equation (5.1) we know that effort increases in q and decreases in r , hence allowing for a restart is also beneficial for a contest designer who wants to maximize average effort in all final matches.

5.4 Discussion

In this section we discuss our findings and assumptions in various ways. First, we want to investigate whether the increase in effort comes solely from the fact that the subjective value of the prize is larger for F-types than for N-types and whether one can reproduce the results when half of the population fights for a larger prize. Second, we discuss the case in which matching in the bidding stage is restricted in the sense that a winner is always paired with a loser (and vice versa). Third, we analyze the mirror case of the joy of winning: What does the introduction of the frustration of losing (instead of the joy of winning) predict in terms of effort and self-selection? Fourth, we describe the effects of introducing both the frustration of losing and the joy of winning into the contest.

5.4.1 Different prize values

In the analysis above, the probability to find a normal types for whom winning the contest is worth V is $1/2$, and hence the probability for a joyful fun-type for whom winning the contest is worth $V + \Delta$ is also $1/2$. We assume that the non-monetary component Δ is not affected when the payoff from the first contest is eliminated. This is an important assumption as we will see below: In a different setup, in which the value of the prize differs between types, but in which all players are "normal" types and only care about the monetary value of the prize (but do not incur a non-monetary joy of winning on top), lemma 5.1 does not hold any more and consequently also the later results do not apply. In other words, the selection effect described above is not driven by differences in monetary prize values, but the non-transient character of the non-monetary joy of winning is an important feature in arriving at the result.

Proposition 5.2 *Suppose that half of the subjects fight for a larger monetary prize, then the subjects with the larger prize are less likely to end up in the restarted contest and effort in the restarted contest will be lower.*

Proof. To see this, assume that the population consists of normal types only, but half of the individuals fight for a prize of value V (the small prize, analogous to the former N-types) and the other half fights for a prize of value $V+\Delta$ (the large prize, therefore call these individuals L-types). In this framework, the equilibria of the first stage contest are completely analogous to the above case with the L-types behaving like the F-types. However, in the second stage, the bids by winning L-types differ from the bids by winning F-types as now the full monetary prize $V+\Delta$ will be deducted if the contest is restarted. Hence, the continuation probability of a pair of two L-types who fight for the larger prize is lower than the probability of a pair of two F-types (see appendix 5.A.4) since of the pairs with two L-types only the pairs with two losers continue. Therefore, the mass of L-L pairs that continues is

$$P\left(LL \text{ cont.}\right) = \frac{1}{2^4\left(2V+\Delta\right)^2}\left[4V^2 + 2V\Delta + \frac{1}{4}\Delta^2\right]. \tag{5.5}$$

Comparing $P\left(NN \text{ cont.}\right)$ as given by (5.3) with $P\left(LL \text{ cont.}\right)$ as given by (5.5) thus reduces to comparing the terms in squared brackets. Since $4V^2 + 2V\Delta + \frac{1}{4}\Delta^2 - \left(4V^2 + 6V\Delta + \frac{9}{4}\Delta^2\right) = -4V\Delta - 2\Delta^2$ is smaller than zero, the probability of L-L pairs continuing in this scenario is lower than the probability of N-N pairs continuing. Thus, the probability that a pair of two N-types ends up in the restarted contest is higher than the probability that a pair of two L-types ends up in the restarted contest. Therefore, the probability of meeting an L-type in stage 3 is lower than the probability of meeting an N-type. This also implies that in this setup, the aggregate effort exerted in the restarted contest is lower than the aggregate effort in the original contest. ■

This highlights again what is driving lemma 5.1. The important difference between pure F-type pairs and pure N-type pairs is that for the pairs with two F-types, one loser in the pair is enough to yield a positive sum of bids for a restart. On the other hand, in the scenario with two different prize values, only the pairs with two losers continue for both types of player pairs. Thus, because normal types are more likely to end up as a loser in the contest against a joyful type or against a type with a larger prize value, there is a higher probability of a match of two losing N-types than of a match of two losing L-types (or F-types). Hence, normal types who fight for the small prize are more likely to enter the restarted contest than normal types who fight for the large prize.

5.4.2 Restricted matching

In the experiment by Herbst (2016b), in which we observed that effort in the restarted contest is higher, matching at the beginning of the second game was not completely random. Instead, in the experiment matching in the second stage was restricted in such a way that a former winner was always paired with a former loser. What does this restriction imply for the above analysis?

The analysis in section 5.3.2 shows that of the pairs with two F-types, those with two losers and those with one loser and one winner reach a positive sum of bids in the second stage and therefore continue to the third stage. Of the pairs with two N-types, only those with two losers continue. Hence, restricting possible pairs to always include a loser and a winner means that all joyful F-types in pure pairs will continue, but none of the normal N-types in pure pairs continues. Hence, the restriction in the experiment has no influence on lemma 5.1 and the following results.

5.4.3 Frustration of losing

Another exercise is to replace the joy of winning as the non-monetary component of the utility function by the frustration of losing. In such a framework, half of the subjects are normal N-types as before and the other half experience a non-monetary frustration of losing Λ in the event they lose. These types who get disappointed by losing we call D-types. The expected payoff for them includes the frustration of losing Λ, with $E\pi_i(x_i) = pr_i(x_A, x_B)V + (1 - pr_i(x_A, x_B))(-\Lambda) - x_i$. For both types, expected payoff can be expressed as

$$E\pi_i(x_i) = \begin{cases} pr_i(x_A, x_B)V - x_i & \text{for an N-type} \\ \\ pr_i(x_A, x_B)(V + \Lambda) - x_i - \Lambda & \text{for a D-type} \end{cases}, \ i = A, B.$$

The assumptions on the frustration of losing are similar to the ones on the joy of winning above with $0 < \Lambda \leq V$, i.e. the non-monetary value of losing is at most as large as the monetary prize value and is positively defined, but enters the expected payoff in a negative way.

Proposition 5.3 *Suppose that half of the subjects get frustrated if they lose. Then, these subjects invest more effort than the other players of the normal type. Moreover, the disappointed subjects are less likely to end up in the restarted contest and effort in the restarted contest will be lower.*

Proof. The first order conditions for the stage 1 contest remain unchanged so that the equilibrium efforts for N-types stay the same and the equilibrium efforts for D-types are the same as they were for F-types above. Nevertheless, expected and realized payoffs for D-types differ from the payoffs for F-types. Therefore, while the probability that a pair of two N-types continues does not change, the probability that a pair of two D-types continues is different from the probability that a pair of two F-types continues. As the expected payoff from the restarted contest includes the possible frustration of losing, bids for a restart by D-types are lower than bids by F-types. We find that the sum of bids by a winning D-type paired with a losing D-type is smaller than zero (see appendix 5.A.5) and also the sum of bids by two losing D-types need not be positive if Λ is close to V in size. Therefore, the probability that a pair of two N-types ends up in the restarted contest is higher than the probability that a pair of two D-types ends up in the restarted contest. ■

Thus, although efforts by players with the frustration of losing are similarly enlarged as in the case of the joy of winning, the selection of players who are motivated by non-monetary incentives into the restarted contest does not apply here. The non-monetary part of the utility rather leads these players to abstain from playing again.

5.4.4 Frustration of losing and joy of winning

If one half of the players are normal types and the other half of the players are types whose objective function includes both, the joy of winning Δ and the frustration of losing Λ, then Δ has to be large enough compared to Λ for the selection effect (and consequently the effort increase) described in the main part of the analysis to occur.

A different exercise is to look at a model where half of the players are joyful types and the other half are disappointed types. From the perspective of the contest designer, the question is: Is it better to draw the participants from a population of joyful and frustrated types or from a purely normal population? It is easy to show that in a framework of joyful and disappointed types, more joyful types than disappointed types continue to play the restarted contest (see appendix 5.A.6). However, if the extent of the joy of winning and the frustration of losing are the same, effort by joyful and disappointed types in the contest is the same. Hence, aggregate effort does not change from the first to the second stage.[19] However, players that are motivated by non-monetary components (be it the frustration of losing or

[19] Of course, assuming that the degree of the joy of winning is larger than the degree of the frustration of losing (i.e. $\Delta > \Lambda$) together with the observation that more joyful than disappointed types enter the restarted contest would immediately yield the result that effort in the restarted contest is higher.

the joy of winning), exert more effort than normal players. Therefore, even if the monetary prize value is the same in both contests, the contest with joyful and frustrated types attracts higher effort. This speaks against the general consensus that more parity is always better (given average ability).

Of course, there are other aspects of the model that could be discussed. Among them is the assumption that players do not expect the second game to take place when they decide on their first stage effort. Another simplification is the assumption of complete information (on your own and your adversary's type). Both of these aspects are left for further research.

5.5 Conclusion

In this paper we analyze selection and effort choices of contestants with and without a joy of winning. The joy of winning is a positive (psychological) component of the utility function that a player obtains when he wins. Players who incorporate this non-monetary component in their maximization problem invest more in the contest and because they also expect to possibly receive the joy of winning if the contest is repeated, they are willing to bid more than the expected monetary value of a replacement contest for a restart of the contest. Therefore, the population of contest participants changes from an equal distribution at the beginning to a skewed distribution in the restarted contest, with more joyful types continuing than types who only fight for the monetary prize. In our framework, all players always know the type of their co-player, but the possibility to bid for a restart comes as a surprise. The theoretical analysis shows that the selection process leads to average effort in the replacement contest being larger (than average effort of the replaced contests and than average effort in the first contest in general). An important characteristic of this model is that if the contest is restarted, the monetary outcome of the first contest is eliminated, but joyful winners keep their joy of winning.

The predictions from our model can rationalize some results from the experiment reported upon in chapter 4. In the analogous experimental setup, the players who continue to the restarted contest are also the ones who expend more effort in the first round. As they are aware of the change in the distribution of types through self-selection, they increase their effort levels in the restarted contest even further.[20] However, the experimental data suggests that there is not only a utility gain of winning for some subjects, but also a utility loss of losing. Yet, the frustration of losing cannot explain the increase in effort observed in the restarted contest. The consequences for selection into the restarted contest of introducing the frustration of losing into the analysis differ from the consequences of introducing the joy of winning. Assuming that losing subjects also incorporate the frustration of losing into their expectations on a restarted contest, these subjects are less likely to end up in the restarted contest. In other words, the continuation probabilities for the different subject types are ranked as follows: Players with a joy of winning are most likely to end up in the restarted contest, players who are not motivated by non-monetary aspects are less likely to end up in the restarted contest and players with a frustration of losing are least likely to end up in the restarted contest. This has consequences for average effort exerted in the contest.

In this paper, we assessed the choice between two types of institutional frameworks if a contest designer wants to maximize effort. One caveat to this is that although a designer of a sports competition or a scientific contest is probably interested in maximizing effort, in other situations effort can be viewed as something negative or wasteful. For example, the joy of winning might make some gamblers expend too much money in the casino so that they go bankrupt. While in such a case only the individual suffers, also more fundamental conflicts up to civil conflicts might suffer from seemingly irrational decisions. The analysis of motivations such as the joy of winning therefore deserves further attention.

[20] Anecdotal evidence suggests that in real life contests, effort in a restarted contest would also go up. Eriks Zaharans, a 2008 winner of the European Union Contest for Young Scientists said "[Winning the contest ...] definitely pushed me to work harder" (https://ec.europa.eu/research/eucys/pdf/where_now/cz_Said_m.pdf)Bedrich Said, a 2011 winner of the European Union Contest for Young Scientist said "If I were able to repeat the contest, I would spend much more time preparing posters and other objects [...]" (https://ec.europa.eu/research/eucys/pdf/where_now/lv_zaharans.pdf)

5.A Appendix

5.A.1 Deriving the first stage equilibria

N-N pairs

Maximizing $E\pi_i(x_i) = \frac{x_i}{x_i+x_j}V - x_i$ with respect to x_i yields the first order condition $\frac{x_j}{(x_i+x_j)^2}V = 1$. By symmetry we get

$$x^*_{i,NN} = \frac{V}{4},$$

where the first capital subscript indicates own type (N) and the second capital subscript indicates the adversary's type (N). Existence and uniqueness of the pure-strategy equilibrium has been shown by Szidarovszky and Okuguchi (1997). With these equilibrium effort levels, expected payoff is $E\pi_i\left(x^*_{i,NN}\right) = \frac{V}{4}$. Realized payoffs depend on a player's winner status and are $\pi_{i,W}\left(x^*_{i,NN}\right) = \frac{3V}{4}$ for a winner and $\pi_{i,L}\left(x^*_{i,NN}\right) = -\frac{V}{4}$ for a loser. Due to symmetry, the probability of being a winner or a loser is $\frac{1}{2}$.

F-F pairs

Maximizing $E\pi_i(x_i) = \frac{x_i}{x_i+x_j}(V+\Delta) - x_i$ with respect to x_i yields the first order condition $\frac{x_j}{(x_i+x_j)^2}(V+\Delta) = 1$. By symmetry we get

$$x^*_{i,FF} = \frac{V+\Delta}{4}.$$

Hence, $E\pi_i\left(x^*_{i,FF}\right) = \frac{V+\Delta}{4}$ and depending on the player's winner status $\pi_{i,W}\left(x^*_{i,FF}\right) = \frac{3(V+\Delta)}{4}$ for a winner and $\pi_{i,L}\left(x^*_{i,FF}\right) = -\frac{(V+\Delta)}{4}$ for a loser. The probability of being a winner or a loser in this case is symmetric (as above) and equal to $\frac{1}{2}$.

Mixed pairs

From the first order conditions for N-types (see section 5.A.1) and F-types (see section 5.A.1), we get $x_jV = (x_i+x_j)^2$ and $x_i(V+\Delta) = (x_i+x_j)^2$, where i is an N-type and j is an F-type. In the interior equilibrium, in which both first order conditions hold, we have

$$x_{i,NF}^{*}=\frac{V^{2}\left(V+\Delta\right)}{\left(2V+\Delta\right)^{2}}$$

and

$$x_{j,FN}^{*}=\frac{V\left(V+\Delta\right)^{2}}{\left(2V+\Delta\right)^{2}}.$$

Hence, $E\pi_{i}\left(x_{i,NF}^{*}\right)=\frac{V^{3}}{(2V+\Delta)^{2}}$ and $E\pi_{j}\left(x_{j,FN}^{*}\right)=\frac{(V+\Delta)^{3}}{(2V+\Delta)^{2}}$. If N is the winner in the mixed pair (which occurs with probability $\frac{V}{2V+\Delta}$), the payoff of the winning N-type is

$$\pi_{i,W}\left(x_{i,NF}^{*}\right)=\frac{V\left(3V^{2}+3V\Delta+\Delta^{2}\right)}{\left(2V+\Delta\right)^{2}}$$

and the payoff of the losing F-type is

$$\pi_{j,L}\left(x_{i,FN}^{*}\right)=\frac{-V\left(V+\Delta\right)^{2}}{\left(2V+\Delta\right)^{2}},$$

whereas if F is the winner in the mixed pair (which occurs with probability $\frac{V+\Delta}{2V+\Delta}$), the payoff of the winning F-type is

$$\pi_{j,W}\left(x_{i,FN}^{*}\right)=\frac{\left(V+\Delta\right)\left(3V^{2}+3V\Delta+\Delta^{2}\right)}{\left(2V+\Delta\right)^{2}}$$

and the payoff of the losing N-type is

$$\pi_{i,L}\left(x_{i,NF}^{*}\right)=\frac{-V^{2}\left(V+\Delta\right)}{\left(2V+\Delta\right)^{2}}.$$

5.A.2 Deriving the continuation probabilities

N-N pairs

Independent of the history, both N-type players expect $E\pi_{i}\left(x_{i,NN}^{*}\right)=\frac{V}{4}$ from the new contest. We compute the sum of bids separately for the different matchings.

We start by computing the sum of bids if both N-types have won against F-types. It is negative:

$$\sum_{i=w_{NF},w_{NF}} b_i = \frac{V}{2} - \frac{2V\left(3V^2+3V\Delta+\Delta^2\right)}{\left(2V+\Delta\right)^2} = \frac{V\left(-4V^2-4V\Delta-\frac{3}{2}\Delta^2\right)}{\left(2V+\Delta\right)^2} < 0.$$

The sum of bids if both N-types have won against N-types is also negative:

$$\sum_{i=w_{NN},w_{NN}} b_i = \frac{V}{2} - \frac{3V}{2} = -V < 0.$$

Therefore, the sum of bids if one N-type has won against an F-type and one N-type has won against an N-type is also negative, i.e.:

$$\sum_{i=w_{NF},w_{NN}} b_i < 0.$$

The sum of bids if one N-type has won against an F-type and one N-type has lost an F-type is negative:

$$\sum_{i=w_{NF},l_{NF}} b_i = \frac{V}{2} - \frac{V\left(3V^2+3V\Delta+\Delta^2\right)}{\left(2V+\Delta\right)^2} + \frac{V^2\left(V+\Delta\right)}{\left(2V+\Delta\right)^2} = -\frac{V\Delta^2}{2\left(2V+\Delta\right)^2} < 0.$$

The sum of bids if one N-type has won against an F-type and one N-type has lost against an N-type is negative:

$$\sum_{i=w_{NF},l_{NN}} b_i = \frac{V}{2} - \frac{V\left(3V^2+3V\Delta+\Delta^2\right)}{\left(2V+\Delta\right)^2} + \frac{V}{4} = -\frac{V\Delta^2}{4\left(2V+\Delta\right)^2} < 0.$$

Therefore, the sum of bids if one N-type has won against an N-type and one N-type has lost against an F-type is also negative since it is equivalent to the last case, the only difference being that the prize is allocated to a different player.

$$\sum_{i=w_{NN},l_{NF}} b_i = -\frac{V\Delta^2}{4\left(2V+\Delta\right)^2} < 0.$$

The sum of bids if one N-type has won against an N-type and one N-type has lost against an N-type is equal to zero:

$$\sum_{i=w_{NN},l_{NN}} b_i = \frac{V}{2} - \frac{3V}{4} + \frac{V}{4} = 0.$$

Therefore, only the pairs wherein both N-types have lost will continue, because the sum of bids for all other combinations is non-positive.

F-F pairs

Independent of the history, both players expect $E\pi_i\left(x^*_{i,FF}\right) = \frac{V+\Delta}{4}$ from the new contest. Note further that when players reach the third stage playing the restarted contest, only the monetary payoffs from the first contest are cancelled, i.e. the joy of winning Δ for winning fun-types is not affected. Therefore, the profit as a winner that is cancelled is smaller by Δ compared to the payoff described in section 5.A.1. Depending on the adversaries' type in the former contest we have $\pi_{i,W}\left(x^*_{i,FF}\right) = \frac{1}{4}(3V - \Delta)$ for an F-type who has won against another F-type and $\pi_{i,W}\left(x^*_{i,FN}\right) = \frac{V\left(3V^2+2V\Delta\right)}{(2V+\Delta)^2}$ for an F-type who has won against an N-type. Below, we compute the sum of bids separately for the different matchings.

The sum of bids by two F-types who have won against F-types is less than or equal to zero:

$$\sum_{i=w_{FF},w_{FF}} b_i = \frac{V+\Delta}{2} - \frac{1}{2}(3V - \Delta) = -V + \Delta \leq 0.$$

If both F-types have won against N-types, the sum of bids is negative:

$$\sum_{i=w_{FN},w_{FN}} b_i = \frac{V+\Delta}{2} - \frac{2V\left(3V^2+2V\Delta\right)}{(2V+\Delta)^2} = \frac{-4V^3 + \frac{5}{2}V\Delta^2 + \frac{1}{2}\Delta^3}{(2V+\Delta)^2} < 0.$$

Therefore, the sum of bids if one F-type has won against an F-type and one F-type has won against an N-type is also negative, i.e.:

$$\sum_{i=w_{FF},w_{FN}} b_i < 0.$$

The sum of bids if one F-type has won against an F-type and one F-type has lost against an F-type is positive:

$$\sum_{i=w_{FF},l_{FF}} b_i = \frac{V+\Delta}{2} - \frac{1}{4}(3V-\Delta) + \frac{V+\Delta}{4} = \Delta > 0.$$

The sum of bids if one F-type has won against an F-type and one F-type has lost against an N-type is positive:

$$\begin{aligned} \textstyle\sum_{i=w_{FF},l_{FN}} b_i &= \tfrac{V+\Delta}{2} - \tfrac{1}{4}(3V-\Delta) + \tfrac{V(V+\Delta)^2}{(2V+\Delta)^2} \\ &= \tfrac{\Delta\left(4V^2+\frac{15}{4}V\Delta+\frac{3}{4}\Delta^2\right)}{(2V+\Delta)^2} > 0. \end{aligned}$$

Therefore, the sum of bids for one winner against a N-type and one loser against a F-type is also positive since it is equivalent to the last case, the only difference being that the prize is allocated to a different player.

$$\sum_{i=w_{FN},l_{FF}} b_i = \frac{\Delta\left(4V^2+\frac{15}{4}V\Delta+\frac{3}{4}\Delta^2\right)}{(2V+\Delta)^2} > 0.$$

The sum of bids if one F-type has won against an N-type and one F-type has lost against an N-type is positive:

$$\begin{aligned} \textstyle\sum_{i=w_{FN},l_{FN}} b_i &= \tfrac{V+\Delta}{2} - \tfrac{V\left(3V^2+2V\Delta\right)}{(2V+\Delta)^2} + \tfrac{V(V+\Delta)^2}{(2V+\Delta)^2} \\ &= \tfrac{\Delta\left(4V^2+\frac{7}{2}V\Delta+\frac{1}{2}\Delta^2\right)}{(2V+\Delta)^2} > 0. \end{aligned}$$

Therefore, not only the pairs wherein both F-players have lost will continue to the restarted contest, but also the pairs of the last four cases, in which one F-type has won and one F-type has lost will continue to the restarted contest.

5.A.3 Frequency of F-F pairs in the restarted contest

Here, we want to analyze whether there are relatively more pairs with two F-types in the restarted contest compared to the initial contest, i.e. whether $q^{new} > q^{old} = \frac{1}{4}$.

For this to be true, it needs to hold that

$$
\begin{aligned}
&\left(\tfrac{p_F+p_M}{p_F+2p_M+p_N}\right)^2 && > \tfrac{1}{4} \\
\Longleftrightarrow\quad & \left(p_F+p_M\right)^2 && > \tfrac{1}{4}\left(p_F+2p_M+p_N\right)^2 \\
\Longleftrightarrow\quad & p_F^2+2p_Fp_M+p_M^2 && > \tfrac{1}{4}\left(p_F^2+4p_Fp_M+2p_Fp_N+4p_M^2+4p_Mp_N+p_N^2\right) \\
\Longleftrightarrow\quad & p_Fp_M-p_Mp_N && > \tfrac{1}{4}p_N^2+\tfrac{1}{2}p_Fp_N-\tfrac{3}{4}p_F^2 \\
\Longleftrightarrow\quad & 4p_M && > \tfrac{p_N^2+2p_Fp_N-3p_F^2}{p_F-p_N}
\end{aligned}
$$

Since $p_F > p_N$, this is true as long as $4p_M > p_N^2 + 2p_Fp_N - 3p_F^2$. The right hand side of this expression is always negative (because $p_N^2 < p_F^2$ and $p_Fp_N < p_F^2$). Hence, the condition collapses to $p_M \geq 0$, which is always fulfilled since the share of mixed pairs continuing to the restarted contest cannot be negative.

5.A.4 Robustness checks

Continuation probabilities with two prizes

When half of the subjects remain being N-types, but instead of F-types, the monetary prize for the other half (called L-types) is enlarged by Δ , nothing changes for N-N pairs (i.e., the analysis is analogous to section 5.A.2). Therefore, we concentrate on the players with the larger prize, i.e. L-types who fight for a prize of value $V+\Delta$ below. For them, the sum of bids are given by the expressions below

The sum of bids if both L-types have won against L-types is negative:

$$\sum_{i=w_{LL},w_{LL}} b_i = \frac{V+\Delta}{2} - \frac{3\left(V+\Delta\right)}{2} = -V-\Delta < 0.$$

The sum of bids if both L-types have won against N-types is negative:

$$\begin{aligned}\textstyle\sum_{i=w_{LN},w_{LN}} b_i &= \tfrac{V+\Delta}{2} - \tfrac{2(V+\Delta)\left(3V^2+3V\Delta+\Delta^2\right)}{(2V+\Delta)^2} \\ &= \tfrac{(V+\Delta)\left(-4V^2-4V\Delta-\frac{3}{4}\Delta^2\right)}{(2V+\Delta)^2} \qquad < 0.\end{aligned}$$

Therefore, the sum of bids if one L-type has won against an L-type and one L-type has won against an N-type is also negative, i.e.:

$$\sum_{i=w_{LL},w_{LN}} b_i < 0.$$

The sum of bids if one L-type has won against an L-type and one L-type has lost against an L-type is equal to zero:

$$\sum_{i=w_{LL},l_{LL}} b_i = \frac{V+\Delta}{2} - \frac{3(V+\Delta)}{4} + \frac{V+\Delta}{4} = 0.$$

The sum of bids if one L-type has won against an L-type and one L-type has lost against an N-type is negative:

$$\sum_{i=w_{LL},l_{LN}} b_i = \frac{V+\Delta}{2} - \frac{3(V+\Delta)}{4} + \frac{V(V+\Delta)^2}{(2V+\Delta)^2} = \frac{(V+\Delta)\left(-\frac{1}{4}\Delta^2\right)}{(2V+\Delta)^2} < 0.$$

Therefore, the sum of bids if one L-type has won against an N-type and one L-type has lost against an L-type is also negative since it is equivalent to the last case, the only difference being that the prize is allocated to a different player.

$$\sum_{i=w_{LN},l_{LL}} b_i = \frac{(V+\Delta)\left(-\frac{1}{4}\Delta^2\right)}{(2V+\Delta)^2} < 0.$$

The sum of bids if one L-type has won against an N-type and one L-type has lost against an N-type is negative:

$$\begin{aligned}\textstyle\sum_{i=w_{LN},l_{LN}} b_i &= \tfrac{V+\Delta}{2} - \tfrac{(V+\Delta)\left(3V^2+3V\Delta+\Delta^2\right)}{(2V+\Delta)^2} + \tfrac{V(V+\Delta)^2}{(2V+\Delta)^2} \\ &= \tfrac{(V+\Delta)\left(-\frac{1}{2}\Delta^2\right)}{(2V+\Delta)^2} \qquad < 0.\end{aligned}$$

Hence, only the L-L pairs with two losers continue so that the probability of L–L pairs that continues is

$$\begin{aligned} P\left(LL \text{ cont.}\right) &= \tfrac{V^2}{2^4(2V+\Delta)^2} + \tfrac{1}{2^6} + \tfrac{V}{2^4(2V+\Delta)} \\ &= \tfrac{1}{2^4(2V+\Delta)^2}\left[4V^2 + 2V\Delta + \tfrac{1}{4}\Delta^2\right]. \end{aligned}$$

5.A.5 Frustration of losing

The equilibrium effort levels for D-types (disappointed types who experience a frustration of losing if they lose) are analogous to the equilibrium effort levels for F-types derived in sections 5.A.1 with $x^*_{i,DD} = \frac{V+\Lambda}{4}$ and $x^*_{j,DN} = \frac{V(V+\Lambda)^2}{(2V+\Lambda)^2}$. The monetary payoffs that would be cancelled if there is a restart are $\pi_{i,W}\left(x^*_{i,DD}\right) = \frac{1}{4}\left(3V - \Lambda\right)$, $\pi_{i,L}\left(x^*_{i,DD}\right) = -\frac{(V+\Lambda)}{4}$ when two D-types played against each other and $\pi_{i,W}\left(x^*_{i,DN}\right) = \frac{V\left(3V^2+2V\Lambda\right)}{(2V+\Lambda)^2}$, $\pi_{i,L}\left(x_{i,DN}\right) = -\frac{V(V+\Lambda)^2}{(2V+\Lambda)^2}$ when a D-type played against an N-type. Independent of the history, both D-type players expect $E\pi_i\left(x^*_{i,DD}\right) = \frac{1}{2}V - \frac{1}{2}\Lambda - \frac{V+\Lambda}{4} = \frac{V-3\Lambda}{4}$ from the new contest, which is lower than the expectation by F-type players.

Therefore, keeping in mind that the sum of bids for two winning F-types is negative and the fact that the expected payoff for D-types is lower than for F-types, we know that the sum of bids for two D-types is always negative, i.e. $\sum_{i=w_{DD},w_{DD}} b_i < 0$, $\sum_{i=w_{DN},w_{DN}} b_i < 0$ and $\sum_{i=w_{DD},w_{DN}} b_i < 0$. Below we compute the sum of bids if one of the D-types in the pair is a winner and the other D-type is a loser.

The sum of bids if one D-type has won against a D-type and one D-type has lost against a D-type is negative:

$$\sum_{i=w_{DD},l_{DD}} b_i = \frac{V-3\Lambda}{2} - \frac{1}{4}\left(3V - \Lambda\right) + \frac{V+\Lambda}{4} = -\Lambda < 0.$$

The sum of bids if one D-type has won against a D-type and one D-type has lost against an N-type is negative:

$$\begin{aligned} \textstyle\sum_{i=w_{DD},l_{DN}} b_i &= \tfrac{V-3\Lambda}{2} - \tfrac{1}{4}\left(3V-\Lambda\right) + \tfrac{V(V+\Lambda)^2}{(2V+\Lambda)^2} \\ &= \tfrac{-16V^2\Lambda - 17V\Lambda^2 - 5\Lambda^3}{4(2V+\Lambda)^2} \qquad < 0. \end{aligned}$$

Therefore, the sum of bids if one D-type has won against an N-type and one D-type has lost against a D-type is also negative since it is equivalent to the last case, the only difference being that the prize is allocated to a different player.

$$\sum_{i=w_{DN},l_{DD}} b_i = \frac{-16V^2\Lambda - 17V\Lambda^2 - 5\Lambda^3}{4\left(2V+\Lambda\right)^2} < 0.$$

The sum of bids if one D-type has won against an N-type and one D-type has lost against an N-type is negative:

$$\begin{aligned}\textstyle\sum_{i=w_{DN},l_{DN}} b_i &= \tfrac{V-3\Lambda}{2} - \tfrac{V\left(3V^2+2V\Lambda\right)}{(2V+\Lambda)^2} + \tfrac{V(V+\Lambda)^2}{(2V+\Lambda)^2} \\ &= \tfrac{-8V^2\Lambda-9V\Lambda^2-3\Lambda^3}{2(2V+\Lambda)^2} \qquad < 0.\end{aligned}$$

As the expected payoff from the restarted contest can be negative with the frustration of losing, we also check whether the sum of bids for two losing D-types is positive.

The sum of bids if both D-types have lost against both D-types is non-negative:

$$\sum_{i=l_{DD},l_{DD}} b_i = \frac{V-3\Lambda}{2} + \frac{V+\Lambda}{2} = V - \Lambda \geq 0.$$

In particular, $\sum_{i=w_{DD},l_{DD}} b_i$ is greater than zero whenever $\Lambda < V$.

If both D-types have lost against N-types, the sign of the sum of bids depends on the relation of V and Λ:

$$\sum_{i=l_{DN},l_{DN}} b_i = \frac{V-3\Lambda}{2} + \frac{2V\left(V+\Lambda\right)^2}{\left(2V+\Lambda\right)^2} = \frac{8V^3 - 7V\Lambda^2 - 3\Lambda^3}{2\left(2V+\Lambda\right)^2} \gtrless 0.$$

$\sum_{i=w_{DN},l_{DN}} b_i$ can be positive or negative, as $8V^3 - 7V\Lambda^2 - 3\Lambda^3$ can be positive (e.g. if $\Lambda = 0$) or negative (e.g. if $\Lambda = V$). The larger Λ gets with respect to V, the more likely it is that the sum of bids for two D-type players who have lost against an N-type is also negative.

Similarly, if one D-type has lost against a D-type and one D-type has lost against an N-type, the sum of bids is also ambiguous:

$$\sum_{i=l_{DD},l_{DN}} b_i = \frac{V-3\Lambda}{2} + \frac{V+\Lambda}{4} + \frac{V\left(V+\Lambda\right)^2}{\left(2V+\Lambda\right)^2} = \frac{16V^3 - 13V\Lambda^2 - 5\Lambda^3}{4\left(2V+\Lambda\right)^2} \gtrless 0.$$

$\sum_{i=w_{DD},l_{DN}} b_i$ is the convex combination of the above two cases, thus it can be positive or negative with the extreme cases again being $\Lambda = 0$ (so that $16V^3 - 13V\Lambda^2 - 5\Lambda^3$ collapses to $16V^3 > 0$) and $\Lambda = V$ (so that $16V^3 - 13V\Lambda^2 - 5\Lambda^3 = -2V^3 < 0$).

5.A.6 Frustration of losing and joy of winning

If half of the subjects are joyful F-types who maximize $E\pi_{i_F}(x_{i_F}) = \frac{x_{i_F}}{x_{i_F}+x_j}(V+\Delta) - x_{i_F}$ and the other half of the subjects are frustrated or disappointed D-types who maximize $E\pi_{i_D}(x_{i_D}) = \frac{x_{i_D}}{x_{i_D}+x_j}(V+\Lambda) - x_{i_D} - \Lambda$, then the first order conditions are $\frac{x_j}{(x_{i_F}+x_j)^2}(V+\Delta) = 1$ and $\frac{x_j}{(x_{i_D}+x_j)^2}(V+\Lambda) = 1$, respectively. If we further assume that $\Delta = \Lambda$ in order not to bias the results into one direction, then $x^*_{i_F} = x^*_{i_D} = \frac{V+\Delta}{4}$. If the contest is restarted, only the monetary payoff of the first contest will be eliminated. Therefore, since effort is the same for both types, first contest payoff is independent of type and co-type. However, the expected payoff from a restarted contest is $E\pi_{i_F}\left(\frac{V+\Delta}{4}\right) = \frac{V}{4} + \frac{\Delta}{4}$ for a joyful type and $E\pi_{i_D}\left(\frac{V+\Delta}{4}\right) = \frac{V}{4} - \frac{3\Delta}{4}$ for a disappointed type. Hence, as players bid the value of the restarted contest (which is the expected payoff from a new contest minus the payoff from the old contest) in the bidding stage, bids by joyful types will be higher. The sum of bids for an F-type who has won the first contest paired with an F-type who has lost the first contest is positive (independent of the adversary in the first contest):

$$\sum_{i=w_F,l_F} b_i = 2\left(\frac{V}{4} + \frac{\Delta}{4}\right) - V + 2\left(\frac{V+\Delta}{4}\right) = \Delta > 0.$$

The sum of bids for a D-type who has won the first contest paired with a D-type who has lost the first contest is negative (independent of the adversary in the first contest):

$$\sum_{i=w_D,l_D} b_i = 2\left(\frac{V}{4} - \frac{3\Delta}{4}\right) - V + 2\left(\frac{V+\Delta}{4}\right) = -\Delta < 0.$$

Thus, of the F-F pairs, all pairs with two losers and the pairs with one winner and one loser continue, but of the D-D pairs, only the pairs with two losers continue. Hence, F-types are more likely to end up in the restarted contest compared to D-types.

Chapter 6

Conclusion

Potential implications from the four chapters strongly depend on the context to which the contest framework is applied. For instance, we have to distinguish whether the aim is to maximize effort in promotion tournaments or research and development contests or to reach peace in warfare. Moreover, the implications depend on the perspective: A contest organizer typically maximizes a different objective than a contest participant and heterogeneity across players also affects the implications. Below, we will list a number of implications that we can draw from the theories outlined and the corresponding three sets of experiments in this thesis.

In order to prevent war, the best solution is to send a well-informed mediator to the conflicting parties who knows about the players' perceived fighting strengths and the feasibility of a prize division. The mediator can suggest an appropriate division, reduce strategic uncertainty, prevent coordination failure, and (potentially) reach peace. Third-party interventions can generally help to decrease wasteful resource-spending in and from fighting. First, if the contest participants can form groups by themselves (rather than by means of an exogenous mechanism), they exert more effort in the contest. Second, if the potential contest participants can select into the contest themselves (rather than being forced to participate), the active participants will exert more effort because only highly motivated players will enter. Third, if the players bargain about the division of a prize themselves (rather than deciding on an exogenous division), negotiations break down most of the time and conflict results. Hence, outside interventions can be beneficial for the contestants and for society.

The contestants typically differ in their motivation or ability and we also find evidence of this kind of heterogeneity. The empirical results of all the experiments in this thesis suggest that the participants are also aware of this heterogeneity and act in a sophisticated manner. They take their relative position and strength into account when they decide on how to divide a prize and on how much effort to exert in a (group) contest. Stronger players insist on receiving a larger share of the pie and dislike being forced into a team with other players. Weaker players are often successful in reaping the benefits of peaceful bargaining and have a strong tendency to join a team in a contest. Actually, the preference for team formation is quite prevalent. If a contest organizer wants to take this preference into account, he must trade-off the positive aspects of strengthening in-group favoritism from endogenous team formation with the positive aspects of forcing a strong player into the team.

In order to maximize effort, the contest organizer should force individuals to interact as stand-alone players (rather than as members of a group in a group contest). Moreover, increasing the salience of winning or stressing the importance of winning increases equilibrium effort - provided that it increases the players' joy of winning. The joy of winning and the frustration of losing are a significant factor in motivating players to expend effort in the experiment. Therefore, it is important to develop a more general understanding of the value placed on non-financial rewards.

From our findings one could derive the hypothesis that a reason why women are less prone to enter a competition than men is that they get more frustrated if they lose and the loss stays on their mind for a longer period of time. This hypothesis is in line with findings that, once women are in a contest, they compete fiercely. Therefore, it would be interesting to analyze whether differences in the competitiveness between men and women can be explained by differences in the degree of the joy of winning and the frustration of losing between them. Moreover, given that the results in this thesis rely on the behavior of students and since heterogeneity can have a huge impact on economic outcomes, it would be valuable to run the experiments also on other parts of the population. This would further increase the external validity of the results derived in this thesis.

English Summary

This thesis studies questions of selection and heterogeneity in contests. A wide array of applications use contest structures, including promotion tournaments, military conflict, and sports contests. Since working with empirical data on real-world conflicts poses a number of challenges in terms of unobservable characteristics, idiosyncrasies of the given conflict and identification strategy, the empirical results in this thesis have been derived using data from theory-guided laboratory experiments. All these experiments have in common that they employ the lottery contest framework by Tullock (1980). We address three main puzzles: alliance formation, outbreak of violent conflict and overexpenditure in conflict.

Chapter 2 analyzes group formation decisions. Due to the public goods nature of group contributions (Olson and Zeckhauser 1966), economic theory views groups to be in a disadvantageous position compared to stand-alone players. In contrast, psychological theory points out that members of a group may be motivated to contribute to the benefit of the group (see e.g., Sherif et al. 1961, Tajfel and Turner 1979, Tajfel 1982). Hence, the moral-hazard problem in groups might be mitigated by factors such as in-group solidarity, especially in the presence of a common enemy. Moreover, when players have heterogeneous incentives, theory predicts that weakly motivated players are more likely to select into the group than strongly motivated players.

We provide evidence for this type of adverse selection for heterogeneity in intrinsic and extrinsic motivation. Despite the adverse selection, effort by voluntarily formed groups is not lower than effort by exogenously formed groups. This speaks in favor of a stimulation of group-spirit through endogenous group formation. We provide evidence for a strategic effect: A player's effort choice depends on the co-player's vote because a player's vote on group formation entails some information about his type. We observe that strongly motivated players who end up in a group against their own vote expend the highest effort. They expect free-riding by their co-player who voted for group formation and try to offset for the little effort. Indeed, those weak players expend the lowest effort.

Chapter 3 analyzes how an asymmetry in players' fighting strengths influences the propensity for the outbreak of resource-wasteful conflict. There is a long-lasting debate on this question in political science. Balance of power theory suggests that conflict is most likely to occur when asymmetry in fighting strengths is large. On the contrary, power transition theory suggests that conflict is most likely to occur when asymmetry in fighting strengths is small. A third argument by Wittman (1979) suggests that the asymmetry in fighting strengths does not influence the likelihood of conflict but only the distribution of resources. Wittman claims that players can take their strengths into account when bargaining about a peaceful solution of the rent. We test Wittman's null hypothesis on the influence of an increasing asymmetry and analyze under which conditions it is easiest for players to reach a peaceful bargaining solution.

We provide evidence in line with Wittman's hypothesis in a treatment with a simple exogenous mediator who proposes an equitable division to the players that accounts for players' fighting strengths. However, when there is no mediator and bargaining involves endogenous demands, the likelihood of conflict increases with the asymmetry in fighting strengths. We find that when the asymmetry in fighting strengths is small, players successfully achieve a 50-50 split in about half of the cases. They seem to deem an equal split to be an appropriate division and the 50-50 split seems to serve as a focal point. Yet, we also find that the slightly advantaged player strongly dislikes ending up being behind. When the asymmetry in fighting strengths increases, individual demands become more dispersed. Hence, players often fail to coordinate and cannot agree on any kind of peaceful division in more than half of the cases. This holds even when the Nash bargaining solution is suggested to the players as a possible (focal) allocation. Surprisingly, bargaining allocates almost the entire surplus from a peaceful division to the disadvantaged player in case a peaceful agreement is reached.

Chapter 4 analyzes the heterogeneity of contest participants with respect to the effort they invest in the contest. We argue that an individual-specific joy of winning that players receive on top of their monetary prize can (partially) explain the overexpenditure and heterogeneity that is typically observed in lottery contest experiments. This argument has already been introduced to the literature (Sheremeta 2010b). This chapter proposes a new measure of the joy of winning: Players can bid money to repeat the first round of a contest, replacing the original first round. In our setup, the extent by which players overbid for playing the contest again compared to the monetary value of a replacement contest measures the joy of winning. We predict that players who have a high joy of winning will exhibit a higher bid-difference than players who have a low joy of winning or who even suffer from a frustration of losing.

We provide evidence that players do not only care about the monetary value of the prize in a contest in the laboratory. In general, winners bid more and losers bid less than predicted. Changes in self-reported satisfaction are in line with these findings. Both measures are positively correlated and there is a substantial degree of heterogeneity in the joy of winning and the frustration of losing across players. Two factors that explain the heterogeneity are the expectedness and the tightness of the outcome. Regarding the behavior in the contest, we find that effort in the restarted contest is higher. This points to a selection of high effort types (with a high joy of winning) and possible procedural or commitment effects of the endogenous decision for a restart.

Chapter 5 analyzes the selection decisions into the restarted contest theoretically. As a companion paper to the previous chapter, it uses the same set-up, but employs a complete information model with two types who differ in their joy of winning. We analyze whether the increase in effort that we observed in the restarted contest of the experiment can be explained by self-selection decisions of the players. The intuition is that those who care more about winning (due to a higher joy of winning) are more likely to end up in the restarted contest. Therefore, the distribution of participating types in the restarted contest is different from the distribution in the original contest. Selection and strategic effects cause effort to increase in the restarted contest.

We provide a theoretical analysis of this intuition in the model, showing that bids for a restart of the contest are increasing with the joy of winning. Hence, as players sort into a contest according to their degree of the joy of winning, average effort in the contest increases. Therefore, a contest designer who wants to maximize effort should allow for self-selection of players if he suspects contest participants to vary in their degree of the joy of winning.

Deutsche Zusammenfassung

Die vorliegende Dissertation beschäftigt sich mit Aspekten von Selektion und Heterogenität in Konflikten und Wettstreitigkeiten. Strukturen solcher Wettkämpfe finden sich in vielen Gebieten, zum Beispiel bei Beförderungen, in militärischen Konflikten oder bei sportlichen Wettbewerben. Da die Arbeit mit empirischen Daten realer Konflikte eine Reihe von Herausforderungen wie unbeobachtbare Charakteristika, spezifische Eigenheiten des vorliegenden Konflikts und das Problem einer sauberen Identifikationsstrategie birgt, wurden die empirischen Ergebnisse dieser Dissertation mit Hilfe theoriegeleiteter Laborexperimente herausgearbeitet. Allen Experimenten ist gemein, dass sie sich des Lotterie-Wettbewerbs von Tullock (1980) bedienen. In dieser Dissertation werden drei wesentliche Fragestellungen besprochen: Allianzenbildung, der Ausbruch gewaltsamer Konflikte und übermäßig hohe Einsätze in Konflikten.

Kapitel 2 untersucht Fragen der Gruppenbildung. Beiträge innerhalb einer Gruppe sind ein öffentliches Gut (Olson and Zeckhauser 1966), daher erachtet die ökonomische Theorie Gruppen im Vergleich zu Einzelspielern als benachteiligt. Dahingegen verweist die psychologische Theorie darauf, dass die Mitglieder einer Gruppe davon motiviert sein können, zum Wohl der Gruppe beizutragen (siehe z.B. Sherif et al. 1961, Tajfel and Turner 1979, Tajfel 1982). Somit könnten die Anreize zu geringen Beiträgen in Teams durch Faktoren wie Solidarität mit der eigenen Gruppe abgeschwächt werden, besonders wenn es eine gegnerische Partei gibt. Außerdem sagt die Theorie voraus, dass es bei heterogenen Anreizen der Spieler dazu kommt, dass schwach motivierte Spieler sich eher in die Gruppe selektieren als stark motivierte Spieler.

Die Experimente in Kapitel 2 belegen diese Art adverser Selektion, wenn die Spieler heterogen hinsichtlich ihrer intrinsischen und/oder extrinsischen Motivation sind. Trotz der adversen Selektion ist der geleistete Einsatz freiwillig gebildeter Gruppen nicht geringer als der Einsatz exogen gebildeter Gruppen. Das spricht dafür, dass freiwillige Gruppenbildung den Teamgeist fördert. Desweiteren haben wir Belege für strategische Effekte gefunden: die Spieler treffen ihre Einsatzentscheidung abhängig davon, ob ihr Mitspieler für oder gegen Gruppenbildung gestimmt hat, da dessen Wahl Informationen über seinen Typ bereithält. Wir beobachten, dass stark motivierte Spieler, die gegen ihre eigene Wahl in eine Gruppe eingeteilt werden, den meisten Einsatz aufbringen. Sie erwarten Trittbrettfahrerverhalten von ihrem Mitspieler, der für Gruppenbildung gestimmt hat und versuchen, den wenigen Einsatz ihres Mitspielers auszugleichen. In der Tat leisten die schwach motivierten Spieler in dieser Konstellation nämlich den geringsten Einsatz.

Kapitel 3 untersucht, wie sich eine Asymmetrie in den Kampfstärken der wettstreitenden Spieler auf die Wahrscheinlichkeit des Ausbruchs eines ressourcenintensiven Konflikts auswirkt. Darüber wird in der Politikwissenschaft schon lange debattiert. Die Anhänger der "balance of power" Theorie legen nahe, dass Konflikt am ehesten ausbricht, wenn es eine große Asymmetrie in den Kampfstärken gibt und dass ein Mächtegleichgewicht am ehesten zu Frieden führt. Im Gegensatz dazu legen die Anhänger der "power transition" Theorie nahe, dass Konflikt am ehesten ausbricht, wenn die Asymmetrie in den Kampfstärken klein ist und dass ein System mit einer dominanten Macht am ehesten zu Frieden führt. Ein drittes Argument, welches auf Wittman (1979) zurückgeht, besagt, dass die Asymmetrie in den Kampfstärken keinen Einfluss auf den Konfliktausbruch hat und nur die Verteilung der Ressourcen beeinflusst. Wittman behauptet, dass die Spieler ihre Stärken berücksichtigen können, wenn sie über eine friedvolle Aufteilung des Preises verhandeln. Wir testen Wittmans Nullhypothese zum Einfluss einer ansteigenden Asymmetrie und analysieren, unter welchen Umständen die Spieler am einfachsten eine friedliche Verhandlungslösung erreichen.

Die Experimente in Kapitel 3 stimmen mit Wittmans Hypothese überein, solange die experimentelle Gestaltung einfach gehalten ist und einen exogenen Mediator vorsieht, der den Spielern eine gerechte Aufteilung des Preises vorschlägt, die sich an den Kampfstärken der Spieler orientiert. Wenn es jedoch keinen solchen Mediator gibt und die Verhandlungen durch endogene Forderungen ablaufen, steigt die Wahrscheinlichkeit eines Konfliktaufbruchs mit der Asymmetrie der Kampfstärken an. Wenn die Asymmetrie in den Kampfstärken gleich ist, zeigt sich, dass sich die Spieler in mehr als der Hälfte der Fälle erfolgreich für eine 50-50-Aufteilung entscheiden. Sie scheinen solch eine gleichmäßige Aufteilung für eine angemessene Aufteilung zu halten und benutzen die 50-50-Aufteilung als einen fokalen Punkt zur Koordination. Es zeigt sich aber auch, dass der leicht begünstigte Spieler eine starke Abneigung dagegen hat, weniger zu erhalten als sein Gegenspieler. Sobald die Asymmetrie in den Kampfstärken ansteigt, nimmt die Streuung der individuellen Forderungen in den Verhandlungen zu. Daher kommt es häufig zu Koordinationsversagen und in mehr als der Hälfte der Fälle können sich die Spieler auf keinerlei friedvolle Aufteilung einigen. Dieses Resultat bleibt auch dann bestehen, wenn die Nash-Verhandlungslösung den Spielern als mögliche (fokale) Aufteilung vorgeschlagen wird. Überraschenderweise führen die Verhandlungen dazu, dass fast der gesamte Überschuss durch eine erfolgreiche friedliche Aufteilung dem benachteiligten Spieler zufließt.

Kapitel 4 untersucht die Heterogenität der Konfliktbeteiligten im Hinblick auf die Kampfaufwendungen, die sie im Konflikt erbringen. Vorgebracht wird, dass die individuelle Freude am Gewinnen, die die Spieler zusätzlich zum Erhalt des monetären Preises erleben, die überhöhten Aufwendungen und die Heterogenität, die diesbezüglich typischerweise in Experimenten zu Lotteriewettstreiten beobachtet wird, (teilweise) erklären kann. Dieses Argument findet sich schon in der vorherigen Literatur (Sheremeta 2010b). Das Kapitel schlägt ein neues Maß vor, um die Freude am Gewinnen zu quantifizieren: Die Spieler können Geld bieten, um die erste Runde eines Wettstreits zu wiederholen. Das Ergebnis des wiederholten Wettstreits ersetzt dann das Ergebnis der ersten Runde. Wieviel Geld ein Spieler bietet um den Wettkampf erneut zu bestreiten (abzüglich des monetären Gegenwerts eines solchen Ersatzwettstreits) ist in unserem Aufbau das Maß für die Freude am Gewinnen. Wir sagen vorher, dass die Differenz beider Werte bei Spielern, die eine hohe Freude am Gewinnen haben, positiver sein wird als bei Spielern, die nur eine geringe Freude am Gewinnen haben oder sogar unter der Frustration des Verlierens leiden.

Die Experimente in Kapitel 4 belegen, dass sich die Spieler im Labor nicht nur für den monetären Preiswert eines Konflikts interessieren. Generell bieten Gewinner mehr für einen Ersatzwettkampf als theoretisch vorhergesagt und Verlierer bieten weniger. Die Veränderungen in der Selbsteinschätzung der eigenen Zufriedenheit stimmen mit diesen Ergebnissen überein. Beide Maße sind positiv korreliert und es wird ein substantieller Grad an Heterogenität bezüglich der Freude am Gewinnen und der Frustration durch Verlieren zwischen den Spielern festgestellt. Wie erwartet und wie knapp das Ergebnis war sind zwei Faktoren, die diese Heterogenität erklären können. Bezüglich des Verhaltens im Konflikt finden wir heraus, dass die Aufwendungen im wiederholten Wettkampf höher sind. Dies spricht für eine Selektion von Spielern, die eine hohe Freude am Gewinnen haben und hohen Einsatz leisten, und für mögliche prozedurale Effekte oder Verpflichtungsgefühle durch die freiwillige und endogene Entscheidung für einen wiederholten Wettstreit.

Kapitel 5 untersucht die Selektionsentscheidungen in den wiederholten Konflikt hinein theoretisch. Die theoretische Analyse komplementiert die experimentelle Untersuchung des vorhergehenden Kapitels. Die Analyse verwendet den gleichen Aufbau wie zuvor und entwickelt ein Modell vollständiger Information mit zwei Typen, die sich hinsichtlich ihrer Freude am Gewinnen unterscheiden. Wir analysieren, ob der Anstieg der Einsatzleistungen, den wir im wiederholten Konflikt des Experiments beobachtet haben, durch Selbstselektionsentscheidungen der Spieler erklärt werden kann. Die Intuition besagt, dass diejenigen, denen mehr am Gewinnen liegt (aufgrund einer höheren Freude am Gewinnen) sich eher im wiederholten Konflikt wiederfinden werden. Daher unterscheidet sich die Verteilung der Wettbewerber im wiederholten Konflikt von der Verteilung im ursprünglichen Konflikt. Selektion und strategische Effekte führen zu einem Anstieg der Einsätze im wiederholten Konflikt.

Die Analyse in Kapitel 5 bietet eine theoretische Fundierung dieser Intuition im Modell. Sie zeigt, dass die Gebote für einen Wiederholungskampf mit der Freude am Gewinnen ansteigen. Somit steigt der Durchschnittseinsatz im Konflikt an, weil sich die Spieler entsprechend ihrer Freude am Gewinnen in den Wettstreit selektieren. Daher sollte ein Organisator eines Wettbewerbs, der die Bemühungen im Wettbewerb maximieren möchte, eine Selbstselektion der Spieler erlauben, wenn er vermutet, dass sich die potentiellen Wettbewerber hinsichtlich ihres Ausmaßes an der Freude am Gewinnen unterscheiden.

Bibliography

[1] Abbink, Klaus, and Jordi Brandts, 2016, Political autonomy and independence: Theory and experimental evidence, Journal of Theoretical Politics 28(3), 461-496..

[2] Abbink, Klaus, Jordi Brandts, Benedikt Herrmann, and Henrik Orzen, 2010, Intergroup conflict and intra-group punishment in an experimental contest game, American Economic Review 100(1), 420-447.

[3] Adam, Marc T. P., Matthias Gamer, Jan Krämer, and Christof Weinhardt, 2011a, Measuring emotions in electronic markets. Proceedings of the International Conference on Information Systems (ICIS). (Shanghai, China). Association for Information Systems. ISBN 978-0-615-55907-0. 1–19.

[4] Adam, Marc T.P., Jan Krämer, Caroline Jähnig, Stefan Seifert, and Christof Weinhardt, 2011b, Understanding auction fever: A framework for emotional bidding, Electronic Markets 21(3), 197-207.

[5] Adam, Marc T. P., Jan Krämer, and Marius B. Müller, 2015, Auction fever! How time pressure and social competition affect bidders' arousal and bids in retail auctions, Journal of Retailing 91(3), 468-485.

[6] Ahn, T. K., R. Mark Isaac, and Timothy C. Salmon, 2008, Endogenous group formation, Journal of Public Economic Theory 10(2), 171-194.

[7] Ahn, T. K., R. Mark Isaac, and Timothy C. Salmon, 2009, Coming and going: Experiments on endogenous group sizes for excludable public goods, Journal of Public Economics 93(1-2), 336-351.

[8] Ahn, T. K., R. Mark Isaac, and Timothy C. Salmon, 2011, Rent-seeking in groups, International Journal of Industrial Organization 29(1), 116-125.

[9] Aimone, Jason, Laurence R. Iannaccone, Michael D. Makowsky, and Jared Rubin, 2013, Endogenous group formation via unproductive costs, Review of Economic Studies 80(4), 1215-1236.

[10] Akerlof, George A., 1970, The Market for "Lemons": Quality uncertainty and the market mechanism, The Quarterly Journal of Economics 84(3), 488-500.

[11] Albarán-Torres, Cesar, 2016, Gambling and addiction? Social casino apps and digital media practices. In: Social, casual and mobile games: The changing gaming landscape, Willson, Michele, and Tama Leaver (editors), Bloomsbury Publishing, ISBN 9781501310584.

[12] Altmann, Steffen, Armin Falk, and Matthias Wibral, 2012, Promotions and incentives: The case of multi-stage elimination tournaments, Journal of Labor Economics 30(1), 149-174.

[13] Amaldoss, Wilfred, and Amnon Rapoport, 2005, Collaborative product and market development: Theoretical implications and experimental evidence, Marketing Science 24(3), 396-414.

[14] Amaldoss, Wilfred, and Amnon Rapoport, 2009, Excessive expenditures in two-stage contests: Theory and experimental evidence. In: Ingrid N. Hangen and Anna S. Nilsen (Eds.), Game Theory: Strategies, Equilibria, and Theorems, Nova Science Publishers, NY, 241-266.

[15] Amegashie, J. Atsu, Charles B. Cadsby, and Yang Song, 2007, Competitive burnout: Theory and experimental evidence, Games and Economic Behavior 59(2), 213-239.

[16] Anbarci, Nejat, and Nick Feltovich, 2013, How sensitive are bargaining outcomes to changes in disagreement payoffs?, Experimental Economics 16(4), 560-596.

[17] Anbarci, Nejat, and Nick Feltovich, 2016, How fully do people exploit their bargaining position? The effects of bargaining institution and the 50–50 norm, Monash Business School, Department of Economics Discussion Paper 21/16.

[18] Anbarci, Nejat, Stergios Skaperdas and Constantinos Syropoulos, 2002, Comparing bargaining solutions in the shadow of conflict: How norms against threats can have real effects, Journal of Economic Theory 106(1), 1-16.

[19] Anderson, Lisa R., and Sarah L. Stafford, 2003, An experimental analysis of rent seeking under varying competitive conditions, Public Choice 115(1-2), 199-216.

[20] Andersson, Malte B., 1994, Sexual selection, Princeton University Press.

[21] Astor, Philipp, Marc Adam, Caroline Jähnig, and Stefan Seifert, 2013, The joy of winning and the frustration of losing: A psychophysiological analysis of emotions in first-price sealed-bid auctions, Journal of Neuroscience, Psychology, and Economics 6(1), 14-30.

[22] Babcock, Philip, Kelly Bedard, Gary Charness, John Hartman, and Heather Royer, 2015, Letting down the team? Social effects of team incentives, Journal of the European Economic Association 13(5), 841-870.

[23] Baik, Kyung Hwan, and Sanghack Lee, 2001, Strategic groups and rent dissipation, Economic Inquiry 39(4), 672-684.

[24] Balafoutas, Loukas, Rudolf Kerschbamer, and Matthias Sutter, 2012, Distributional preferences and competitive behavior, Journal of Economic Behavior & Organization 83(1), 125-135.

[25] Baron, David P. , 1994, Electoral competition with informed and uninformed voters, The American Political Science Review 88(1), 33-47.

[26] Bartling, Björn, Ernst Fehr, Michel André Maréchal and Daniel Schunk, 2009, Egalitarianism and competitiveness, American Economic Review Papers and Proceedings 99(2), 93-98.

[27] Baumeister, Roy F., Ellen Bratslavsky, Catrin Finkenauer, and Kathleen D. Vohs, 2001, Bad is stronger than good, Review of General Psychology 5(4), 323-370.

[28] Baye, Michael R., and Heidrun C. Hoppe, 2003, The strategic equivalence of rent-seeking, innovation, and patent-race games, Games and Economic Behavior 44(2), 217-226.

[29] Baye, Michael R., Dan Kovenock, and Casper G. de Vries, 1993, Rigging the lobbying process: An application of the all-pay auction, American Economic Review 83(1), 289-294.

[30] Baye, Michael R., Dan Kovenock, and Casper G. de Vries, 2005, Comparative analysis of litigation systems: An auction-theoretic approach, Economic Journal 115(505), 583-601.

[31] Beardsley, Kyle, 2011, The mediation dilemma, Cornell University Press.

[32] Benenson, Joyce F., Henry Markovits, Melissa E. Thompson, and Richard W. Wrangham, 2009, Strength determines coalitional strategies in humans, Proceedings of the Royal Society B: Biological Sciences 276, 2589-2595.

[33] Benson, Brett V., Adam Meirowitz and Kristopher W. Ramsay, 2014, The distribution of power and the risk of war in crisis bargaining, http://www.princeton.edu/~ameirowi/working/neutrality_070614.pdf.

[34] Bercovitch, Jacob, and Gerald Schneider, 2000, Who mediates? The political economy of international conflict management, Journal of Peace Research 37(2), 145-165.

[35] Bercovitch, Jacob, and Scott S. Gartner, 2009, New approaches, methods, and findings in the study of mediation. In: Jacob Bercovitch and Scott S. Gartner (eds.): International Conflict Mediation: New Approaches and Findings, New York: Routledge, 1-15.

[36] Bernhard, Helen, Urs Fischbacher, and Ernst Fehr, 2006, Parochial altruism in humans, Nature 442(7105), 912-915.

[37] Bester, Helmut, and Karl Wärneryd, 2006, Conflict and the social contract, The Scandinavian Journal of Economics 108(2), 231-249.

[38] Blainey, Geoffrey, 1988, The Causes of War, 3rd ed. New York: The Free Press.

[39] Bloch, Francis, 2012, Endogenous formation of alliances in contests. In: Michelle R. Garfinkel and Stergios Skaperdas (Eds.), Oxford Handbook of the Economics of Peace and Conflict, Oxford University Press, 473-502.

[40] Bloch, Francis, Santiago Sánchez-Pagés, and Raphael Soubeyran, 2006, When does universal peace prevail? Secession and group formation in conflict, Economics of Governance 7(1), 3-29.

[41] Bosman, Ronald, Roman Kräussl, and Thomas van Galen, 2014, Emotions-at-risk: An experimental investigation into emotions, option prices and risk perception, LSF Research Working Paper Series No 14-11.

[42] Bossuyt, Evelien, Agnes Moors, and Jan De Houwer, 2014, Unexpected and Just Missed: The Separate Influence of the Appraisals of Expectancy and Proximity on Negative Emotions, Emotion 14(2), 284-300.

[43] Boun My, Kene, and Benoît Chalvignac, 2010, Voluntary participation and cooperation in a collective-good game, Journal of Economic Psychology 31(4), 705-718.

[44] Boyce, Christopher J., Gordon D.A. Brown and Simon C. Moore, 2010, Money and happiness: Rank of income, not income, affects life satisfaction, Psychological Science 21(4), 471-475.

[45] Bradler, Christiane, Robert Dur, Susanne Neckermann and Arjan Non, 2016, Employee recognition and performance: A field experiment, Management Science 62(11), 3085-3099.

[46] Brandts, Jordi, Arno Riedl, and Frans van Winden, 2009, Competitive rivalry, social disposition, and subjective well-being: An experiment, Journal of Public Economics 93(11), 1158-1167.

[47] Brewer, Marilynn B., 1979, In-group bias in the minimal intergroup situation: A cognitive-motivational analysis, Psychological Bulletin 86(2), 307-324.

[48] Brookins, Philip, and Dmitry Ryvkin, 2014, An experimental study of bidding in contests of incomplete information, Experimental Economics 17(2), 245-261.

[49] Bühren, Christoph, and Marco Pleßner, 2014, The trophy effect, Journal of Behavioral Decision Making 27(4), 363-377.

[50] Bull, Clive., Andrew Schotter and Keith Weigelt, K., 1987, Tournaments and piece rates: An experimental study, Journal of Political Economy 95(1), 1–33.

[51] Buser, Thomas, The impact of losing in a competition on the willingness to accept further challenges, Management Science, doi:10.1287/mnsc.2015.2321, forthcoming.

[52] Cason, Timothy N., Roman M. Sheremeta, and Jingjing Zhang, 2012, Communication and efficiency in competitive coordination games, Games and Economic Behavior 76(1), 26-43.

[53] Cason, Timothy N., William A. Masters, and Roman M. Sheremeta, 2010, Entry into winner-take-all and proportional-prize contests: An experimental study, Journal of Public Economics 94(9-10), 604-611.

[54] Cason, Timothy N., William A. Masters and Roman M. Sheremeta, 2013, Winner-take-all and proportional-prize contests: Theory and experimental results, Working Paper, http://dx.doi.org/10.2139/ssrn.2014994.

[55] Chadefaux, Thomas, 2011, Bargaining over power: When do shifts in power lead to war?, International Theory 3(2), 228-253.

[56] Chark, Robin, Amnon Rapoport, and Rami Zwick, 2011, Experimental comparison of two multiple-stage contest designs with asymmetric players, Public Choice 147(3), 305-329.

[57] Charness, Gary, Luca Rigotti, and Aldo Rustichini, 2007, Individual behavior and group membership, American Economic Review 97(4), 1340-1352.

[58] Charness, Gary, and Chun-Lei Yang, 2014, Starting small towards voluntary formation of efficient large groups in public goods provision, Journal of Economic Behavior & Organization 102, 119-132.

[59] Chen, Hua, Sung H. Ham, and Noah Lim, 2011, Designing multi-person tournaments with asymmetric contestants: An experimental study, Management Science 57(5), 864-883.

[60] Chen, Roy, and Yan Chen, 2011, The potential of social identity for equilibrium selection, American Economic Review 101(6), 2562-2589.

[61] Chen, Yan and John O. Ledyard, 2008, Mechanism design experiments. In: The New Palgrave Dictionary of Economics, Second Edition. Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave Macmillan.

[62] Chen, Yan, and Sherry Xin Li, 2009, Group identity and social preferences, American Economic Review 99(1) 431-457.

[63] Cherry, Todd L., and Stephen J. Cotten, 2011, Sleeping with the enemy: The economic cost of internal environmental conflicts, Economic Inquiry 49(2), 530-539.

[64] Cherry, Josh, Stephen Salant, and Neslihan Uler, 2015, Experimental departures from self-interest when competing partnerships share output, Experimental Economics 18(1), 89-115.

[65] Choi, Jay Pil, 2005, Live and Let Live: A Tale of Weak Patents, Journal of the European Economic Association 3(2-3), 724-733.

[66] Clark, Derek J., and Christian Riis, 1998, Contest success functions: An extension, Economic Theory 11(1), 201-204.

[67] Claude, Inis L., 1962, Power and International Relations, New York: Random House.

[68] Coffey, Bentley, and M. T. Maloney, 2010, The thrill of victory: Measuring the incentive to win, Journal of Labor Economics 28(1), 87-112.

[69] Cohen, Chen, and Aner Sela, 2005, Manipulations in contests, Economics Letters 86(1), 135-139.

[70] Cohen, Chen, and Tal Shavit, 2012, Experimental tests of Tullock's contest with and without winner refunds, Research in Economics 66(3), 263-272.

[71] Cornes, Richard, and Roger Hartley, 2007, Aggregative public good games, Journal of Public Economic Theory 9(2), 201-219.

[72] Cotton, Christopher, Cheng Li, Frank McIntyre, and Joseph Price, 2015, Which explanations for gender differences in competition are consistent with a simple game theoretic model?, Journal of Behavioral and Experimental Economics 59, 56-67.

[73] Cowley, Elizabeth, 2008, Looking back at an experience through rose-colored glasses, Journal of Business Research 61(10), 1046-1052.

[74] Croson, Rachel, and James Sundali, 2005, The gambler's fallacy and the hot hand: Empirical data from casinos, The Journal of Risk and Uncertainty 30(3), 195-209.

[75] Dal Bo, Pedro, Andrew Foster, and Louis Putterman, 2010, Institutions and behavior: Experimental evidence on the effects of democracy, American Economic Review 100(5), 2205-2229.

[76] Dannenberg, Astrid, Andreas Lange, and Bodo Sturm, 2014, Participation and commitment in voluntary coalitions to provide public goods, Economica 81(322), 257-275.

[77] Davis, Douglas D., and Robert J. Reilly, 1998, Do many cooks always spoil the stew? An experimental analysis of rent seeking and the role of a strategic buyer, Public Choice 95(1-2), 89-115.

[78] Dechenaux, Emmanuel, Dan Kovenock, and Roman M. Sheremeta, 2015, A survey of experimental research on contests, all-pay auctions and tournaments, Experimental Economics 18(4), 609-669.

[79] Descamps, Ambroise, Changxia Ke and Lionel Page, 2016, Psychological and Strategic Momentum: An experimental analysis, mimeo.

[80] Dillon, Robin L. and Catherine H. Tinsley, 2008, How Near-Misses Influence Decision Making Under Risk: A Missed Opportunity for Learning, Management Science 54(8), 1425-1440.

[81] Ding, Min, Jehoshua Eliashberg, Joel Huber, and Ritesh Saini, 2005, Emotional bidders - An analytical and experimental examination of consumers' behavior in a priceline-like reverse auction, Management Science 51(3), 352-364.

[82] Dohmen, Thomas, and Armin Falk, 2011, Performance pay and multidimensional sorting: Productivity, preferences, and gender, American Economic Review 101(2), 556-590.

[83] Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp and Gert G. Wagner, 2011a, Individual risk attitudes: Measurement, determinants, and behavioral consequences, Journal of the European Economic Association 9(3), 522-550.

[84] Dohmen, Thomas, Armin Falk, Klaus Fliessbach, Uwe Sunde, and Bernd Weber, 2011b, Relative versus absolut income joy of winning,

and gender: Brain imaging evidence, Journal of Public Economics 95(3), 279-295.

[85] Eaton, B. Curtis, Mukesh Eswaran, and Robert J. Oxoby, 2011, 'Us' and 'them': The origin of identity, and its economic implications, Canadian Journal of Economics 44(3), 719-748.

[86] Ehrhart, Karl-Martin, and Claudia Keser, 1999, Mobility and cooperation: On the run, CIRANO Working Paper No. 99s-24.

[87] Eisenkopf, Gerald, and André Bächtiger, 2013, Mediation and conflict prevention, Journal of Conflict Resolution 57(4), 570-597.

[88] Epstein, Gil S. and Shmuel Nitzan, 2004, Strategic restraint in contests, European Economic Review 48(1), 201-210.

[89] Eriksson, Tor, Sabrina Teyssier, and Marie-Claire Villeval, 2009, Self-selection and the efficiency of tournaments, Economic Inquiry 47(3), 530-548.

[90] Ernst, Christiane, and Christian Thöni, 2013, Bimodal bidding in experimental all-pay auctions. Games 4(4), 608–623.

[91] Esteban, Joan M., and Debraj Ray, 2001, Collective action and the group size paradox, American Political Science Review 95(3), 663-672.

[92] Esteban, Joan M., and József Sákovics, 2003, Olson vs. Coase: Coalitional worth in conflict, Theory and Decision 55(4), 339-357.

[93] Fearon, James D., 1995, Rationalist explanations for war, International Organization 49(3), 379-414.

[94] Ferris, W.M., 1973, The power capabilities of nation-states: International conflict and war, Lexington, Mass: Lexington Books.

[95] Fischbacher, Urs, 2007, Z-tree: Zurich tool box for ready-made economic experiments, Experimental Economics 10(2), 171-178.

[96] Frank, Robert H., 1984a, Are workers paid their marginal products?, American Economic Review 74(4), 549-571.

[97] Frank, Robert H., 1984b, Interdependent preferences and the competitive wage structure, Rand Journal of Economics 15(4), 510-520.

[98] Frank, Robert H., 1985a, The demand for unobservable and other nonpositional goods, American Economic Review 75(1), 101-116.

[99] Frank, Robert H., 1985b, Choosing the right pond: Human behavior and the quest for status, Oxford University Press, New York.

[100] Franken, Robert E., and Douglas J. Brown, 1995, Why do people like competition? Motivation for winning, putting forth effort, improving one's performance, performing well, being instrumental, and expressing forceful/aggressive behavior, Personality and individual differences 19(2), 175-184.

[101] Fukuda, Emiko, Yoshio Kamijo, Ai Takeuchi, Michiharu Masui, and Yukihiko Funaki, 2013, Theoretical and experimental investigations of the performance of keyword auction mechanisms, RAND Journal of Economics 44(3), 438-461.

[102] Fullerton, Richard L., and R. Preston McAfee, 1999, Auctioning entry into tournaments, Journal of Political Economy 107(3), 573-605.

[103] Garfinkel, Michelle R., 2004, Stable alliance formation in distributional conflict, European Journal of Political Economy 20(4), 829-852.

[104] Garnham, David, 1976, Power parity and lethal international violence, 1969-1973, Journal of Conflict Resolution 20(3), 379-394.

[105] Gauriot, Romain, and Lionel Page, 2016, Does success breed success? A quasi-experiment on strategic momentum in dynamic contests, Qube Working Paper No. 28, http://www.uq.edu.au/economics/PHD2015/papers/Gauriot_Does%20success%20breed%20success_a%20quasi%20experiment%20on%20strategic%20momentum%20in%20dynamic%20contests.pdf.

[106] Gilovich, Thomas, Robert Vallone, and Amos Tversky, 1985, The hot hand in basketball: On the misperception of random sequences, Cognitive Psychology 17(3), 295-314.

[107] Goette, Lorenz, David Huffman, and Stephan Meier, 2012a, The impact of social ties on group interactions: Evidence from minimal groups and randomly assigned real groups, American Economic Journal: Microeconomics 4(1), 101-115.

[108] Goette, Lorenz, David Huffman, Stephan Meier, and Matthias Sutter, 2012b, Competition between organizational groups: Its impact on altruistic and antisocial motivations, Management Science 58(5), 948-960.

[109] Gradstein, Mark, 1995, Intensity of competition, entry and entry deterrence in rent seeking contests, Economics and Politics 7(1), 79-91.

[110] Grafen, Alan, 1987, The logic of divisively asymmetric contests: Respect for ownership and the desperado effect, Annimal Behavior 35(2), 462-467.

[111] Greiner, Ben, 2004. An online recruitment system for economic experiments. In: Kurt Kremer, Volker Macho (eds.): Forschung und wissenschaftliches Rechnen 2003. GWDG Bericht 63, Göttingen: Ges. für Wiss. Datenverarbeitung, 79-93.

[112] Gulick, Edward V., 1955, Europe's classical balance of power: A case history of the theory and practice of one of the great concepts of European statecraft, Ithaca, NY: Cornell University Press.

[113] Haran, Uriel, and Ilana Ritov, 2014, Know who you're up against: Counterpart identifiability enhances competitive behavior, Journal of Experimental Social Psychology 54, 115-121.

[114] Hardy, Ian C. W., and Mark Briffa, 2013, Animal contests, Cambridge University Press.

[115] Harhoff, Dietmar, 2009, Economic Cost-Benefit Analysis of a Unified and Integrated European Patent Litigation System, Final Report to the European Commission.

[116] Hart, Einav, Judith Avrahami, Yaakov Kareev, and Peter M. Todd, 2015, Investing even in uneven contests: Effects of asymmetry on

investment in contests, Journal of Behavioral Decision Making 28(4), 395-409.

[117] Heckman, James J., 1979, Sample selection bias as a specification error, Econometrica 47(1), 153-161.

[118] Herbst, Luisa, 2016a, On the self-selection of happy winners, mimeo.

[119] Herbst, Luisa, 2016b, Who pays to win again? The joy of winning in contest experiments, Max Planck Institute for Tax Law and Public Finance Working Paper 2016-06.

[120] Herbst, Luisa, Kai A. Konrad, and Florian Morath, 2015, Endogenous group formation in experimental contests, European Economic Review 74, 163-189.

[121] Herbst, Luisa, Kai A. Konrad, and Florian Morath, 2016, Balance of power and the propensity of conflict, Games and Economic Behavior, doi:10.1016/j.geb.2015.12.013.

[122] Herrmann, Benedikt, and Henrik Orzen, 2008, The appearance of homo rivalis: social preferences and the nature of rent seeking, CeDEx Discussion Paper No. 2008-10.

[123] Hirsch, Fred, 1976, Social Limits to Growth, Harvard University Press, Cambridge, MA.

[124] Hirshleifer, Jack, and Evan Osborne, 2001, Truth, effort, and the legal battle, Public Choice 108(1), 169-195.

[125] Hirshleifer, Jack, and John G. Riley, 1992, The Analytics of Uncertainty and Information, Cambridge University Press, Cambridge UK.

[126] Hörner, Johannes, Massimo Morelli and Francesco Squintani, 2015, Mediation and peace, Review of Economic Studies 82(4), 1483-1501.

[127] Hörtnagl, Tanja, Rudolf Kerschbamer, Rudi Stracke and Uwe Sunde, 2013, Heterogeneity in rent-seeking contests with multiple stages: Theory and experimental evidence, Working Papers in Economics and Statistics 2013-29, University of Innsbruck.

[128] Holmstrom, Bengt, 1982, Moral hazard in teams, Bell Journal of Economics 13(2), 324-340.

[129] Houweling, Henk, and Jan G. Siccama, 1988, Power transitions as a cause of war, Journal of Conflict Resolution 32(1), 87-102.

[130] Jackson, Matthew O., and Massimo Morelli, 2011, The reasons for wars: An updated survey. In: Christopher J. Coyne, Rachel L. Mathers (eds.): The Handbook on the Political Economy of War, Cheltenham, UK: Edward Elgar, 34-57.

[131] Johnson, David, and Timothy C. Salmon, 2016, Sabotage versus Discouragement: Which Dominates Post Promotion Tournament Behavior?, Southern Economic Journal 82(3), 673-696.

[132] Jordan, James S., 2006, Pillage and property, Journal of Economic Theory 131(1), 26-44.

[133] Kaplan, Morton A., 1957, System and Process in International Politics, New York: John Wiley & Sons.

[134] Kasumovic, Michael M., and Jeffrey H. Kuznekoff, 2015, Insights into sexism: Male status and performance moderates female-directed hostile and amicable behaviour, PLoS ONE 10(7), doi:10.1371/journal.pone.0131613.

[135] Katz, Eliakim, Shmuel Nitzan, and Jacob Rosenberg, 1990, Rent-seeking for pure public goods, Public Choice 65(1), 49-60.

[136] Ke, Changxia, Kai. A. Konrad, and Florian Morath, 2013, Brothers in arms - An experiment on the alliance puzzle, Games and Economic Behavior 77(1), 61-76.

[137] Ke, Changxia, Kai A. Konrad and Florian Morath, 2015, Alliances in the shadow of conflict, Economic Inquiry 53(2), 854-871.

[138] Keser, Claudia, and Claude Montmarquette, 2011, Voluntary versus enforced team effort, Games 2(3), 277-301.

[139] Kim, Woosang, and James D. Morrow, 1992, When do power shifts lead to war?, American Journal of Political Science 36(4), 896-922.

[140] Kidd, Michael, Aaron Nicholas, and Birendra Rai, 2013, Tournament outcomes and prosocial behavior, Journal of Economic Psychology 39, 387-401.

[141] Kimball, Anessa L., 2006, Alliance formation and conflict initiation: The missing link, Journal of Peace Research 43(4), 371-389.

[142] Kimbrough, Erik O., and Roman M. Sheremeta, 2013, Side-payments and the costs of conflict, International Journal of Industrial Organization 31(3), 278-286.

[143] Kimbrough, Erik O., and Roman M. Sheremeta, 2014, Why can't we be friends? Entitlements and the costs of conflict, Journal of Peace Research 51(4), 487-500.

[144] Kimbrough, Erik O., Jared Rubin, Roman M. Sheremeta and Timothy Shields, 2015, Commitment problems in conflict resolution, Journal of Economic Behavior and Organization 112, 33-45.

[145] Kimbrough, Erik O., Roman M. Sheremeta and Timothy Shields, 2014, When parity promotes peace: Resolving conflict between asymmetric agents, Journal of Economic Behavior and Organization 99, 96-108.

[146] Kleine, Marco, Pascal Langenbach, and Lilia Zhurakovska, 2016, Fairness and Persuasion: How Stakeholder Communication Affects Impartial Decision Making, Economics Letters 141, 173-176.

[147] Klose, Bettina, and Roman M. Sheremeta, 2012, Behavior in all-pay and winner-pay auctions with identity-dependent externalities. Working Paper.

[148] Klumpp, Tilman and Mattias K. Polborn, 2006, Primaries and the New Hampshire Effect, Journal of Public Economics 90(6-7), 1073-1114.

[149] Kocher, Martin, Sabine Strauß, and Matthias Sutter, 2006, Individual or team decision-making - Causes and consequences of self-selection, Games and Economic Behavior 56(2), 259-270.

[150] Konrad, Kai A., 2009, Strategy and dynamics in contests, Oxford University Press.

[151] Konrad, Kai A., 2014, Strategic aspects of fighting in alliances, in: Karl Wärneryd (ed.), The Economics of Conflict, Theory and Empirical Evidence, MIT Press, 1-22.

[152] Konrad, Kai A., and Dan Kovenock, 2009, The alliance formation puzzle and capacity constraints, Economics Letters 103, 84-86.

[153] Konrad, Kai A., and Florian Morath, 2012, Evolutionarily stable in-group favoritism and out-group spite in intergroup conflict, Journal of Theoretical Biology 306, 61-67.

[154] Konrad, Kai A., and Kjell Erik Lommerud, 1993, Relative standing comparisons, risk taking, and safety regulations, Journal of Public Economics 51(3), 345-358.

[155] Kovenock, Dan, and Brian Roberson, 2012, Coalitional Colonel Blotto games with application to the economics of alliances, Journal of Public Economic Theory 14(4), 653-676.

[156] Kräkel, Matthias, 2008, Emotions in tournaments, Journal of Economic Behavior & Organization 67(1), 204-214.

[157] Krupka, Erin L., and Roberto A. Weber, 2013, Identifying social norms using coordination games: Why does dictator game sharing vary?, Journal of the European Economic Association 11(3), 495-524.

[158] Kuhn, Peter, and Marie Claire Villeval, 2015, Are women more attracted to co-operation than men?, The Economic Journal 125(582), 115-140.

[159] Kuziemko, Ilyana, Ryan W. Buell, Tally Reich and Michael I. Norton, 2014, "Last-place aversion": Evidence and redistributive implications, Quarterly Journal of Economics 129(1), 105-149.

[160] Kydd, Andrew H., 2010, Rationalist approaches to conflict prevention and resolution, Annual Review of Political Science 13, 101-121.

[161] Lacomba, Juan A., Francisco Lagos, Ernesto Reuben and Frans van Winden, 2014, On the escalation and de-escalation of conflict, Games and Economic Behavior 86, 40-57.

[162] Lang, Harald, and Florian Morath, 2015, A glance into the tunnel: Experimental evidence on income comparisons under uncertainty, Max Planck Institute for Tax Law and Public Finance Working Paper 2015-13, doi:10.2139/ssrn.2703756.

[163] Lazear, Edward P., and Sherwin Rosen, 1981, Rank-order tournaments as optimum labor contracts, Journal of Political Economy 89(5), 841-864.

[164] Lazear, Edward P., and Kathryn L. Shaw, 2007, Personnel economics: The economist's view of human resources, Journal of Economic Perspectives 21(4), 91-114.

[165] Levy, Jack S., 1987, Declining power and the preventive motivation for war, World Politics 40(1), 82-107.

[166] Li, Sherry Xin, Kutsal Dogan, and Ernan Haruvy, 2011, Group identity in markets, International Journal of Industrial Organization 29(1), 104-115.

[167] Lim, Noah, Michael Ahearne and Sung H. Ham, 2009, Designing sales contests: Does the prize structure matter?, Journal of Marketing Research 46(3), 356-371.

[168] Luhtanen, Riia, and Jennifer Crocker, 1992, A collective self-esteem scale: Self-evaluation of one's social identity, personality and social psychology bulletin 18(3), 302-318.

[169] Mago, Shakun, Roman Sheremeta, and Andrew Yates, 2013, Best-of-three contests: Strategic versus psychological momentum, International Journal of Industrial Organization 31(3), 287-296.

[170] Malhotra, Deepak, 2010, The desire to win: The effects of competitive arousal on motivation and behavior, Organizational Behavior and Human Decision Processes 111(2), 139-146.

[171] Malhotra, Deepak, Gillian Ku, and J. Keith Murnighan, 2008, When winning is everything, Harvard Business Review May 2008, 78-86.

[172] Malueg, David A., and Andrew J. Yates, 2004, Rent seeking with private values, Public Choice 119(1-2), 161-178.

[173] Matsumoto, David, and Bob Willingham, 2006, The thrill of victory and the agony of defeat: Spontaneous expressions of medal winners of the 2004 Athens Olympic Games, Journal of Personality and Social Psychology 91(3), 568-581.

[174] Maynard Smith, John, 1974, The theory of games and the evolution of animal conflicts, Journal of Theoretical Biology 47(1), 209-221.

[175] McBride, Michael, and Stergios Skaperdas, 2014, Conflict, settlement, and the shadow of the future, Journal of Economic Behavior and Organization 105, 75-89.

[176] Mellers, Barbara A., Allan Schwartz, Katty Ho, and Ilana Ritov, 1997, Decision affect theory: Emotional reactions to the outcomes of risky options, Psychological Science 8(6), 423-429.

[177] Metzger, Lars P., 2015, Alliance formation in contests with incomplete information, Ruhr Economic Papers No. 544, http://dx.doi.org/10.4419/86788622.

[178] Millner, Edward L., and Michael D. Pratt, 1989, An experimental investigation of efficient rent-seeking, Public Choice 62(2), 139-151.

[179] Millner, Edward L., and Michael D. Pratt, 1991, Risk aversion and rent-seeking: An extension and some experimental evidence, Public Choice 69(1), 81-92.

[180] Morgan, John, Henrik Orzen, and Martin Sefton, 2012, Endogenous entry in contests, Economic Theory 51(2), 435-463.

[181] Morgan, John, Henrik Orzen, Martin Sefton, and Dana Sisak, 2016, Strategic and natural risk in entrepreneurship: An experimental study, Journal of Economics & Management Strategy 25(2), 420-454.

[182] Morgenthau, Hans, 1948, Politics among nations: The struggle for power and peace, New York: Alfred A Knopf.

[183] Morrow, James D., 1989, Capabilities, uncertainty, and resolve: A limited information model of crisis bargaining, American Journal of Political Science 33(4), 941-972.

[184] Müller, Holger M., and Karl Wärneryd, 2001, Inside versus outside ownership: A political theory of the firm, RAND Journal of Economics 32(3), 527-541.

[185] Münster, Johannes, 2009, Repeated contests with asymmetric information, Journal of Public Economic Theory 11(1), 89-118.

[186] Nalbantian, Haig R., and Andrew Schotter, 1997, Productivity under group incentives: An experimental study, American Economic Review 87(3), 314-341.

[187] Nash, John F., 1953, Two-person cooperative games, Econometrica 21(1), 128-140.

[188] Nitzan, Shmuel, 1991, Collective rent dissipation, Economic Journal 101(409), 1522-1534.

[189] Nitzan, Shmuel, 1994, Modeling rent-seeking contests, European Journal of Political Economy 10(1), 41-60.

[190] Olson, Mancur, and Richard Zeckhauser, 1966, An economic theory of alliances, The Review of Economics and Statistics 48(3), 266-279.

[191] Organski, Abramo F.K., 1958, World Politics, New York: Alfred A. Knopf.

[192] Organski, Abramo F.K., and Jacek Kugler, 1980, The War Ledger, Chicago: The University of Chicago Press.

[193] Page, Talbot, Louis Putterman, and Bulent Unel, 2005, Voluntary association in public goods experiments: Reciprocity, mimicry and efficiency, Economic Journal 115(506), 1032-1053.

[194] Parco, James E., Amnon Rapoport, and Wilfred Amaldoss, 2005, Two-stage contests with budget constraints: An experimental study, Journal of Mathematical Psychology 49(4), 320-338.

[195] Parker, Geoffrey A., 1974, Assessment strategy and the evolution of fighting behavior, Journal of Theoretical Biology 47(1), 223-243.

[196] Perez-Truglia, Ricardo, 2015, A Samuelsonian validation test for happiness data, Journal of Economic Psychology 49, 74-83.

[197] Piccione, Michele, and Ariel Rubinstein, 2007, Equilibrium in the jungle, Economic Journal 117(522), 883-896.

[198] Polborn, Mattias K., and Zaruhi Sahakyan, 2007, Dynamic lobbying conflicts, Economics of Governance 8(3), 263-279.

[199] Potters, Jan C., Casper G. de Vries, and Frans van Winden, 1998, An experimental examination of rational rent seeking, European Journal of Political Economy 14(4), 783-800.

[200] Powdthavee, Nattavudh, 2009, How important is rank to individual perception of economic standing? A within-community analysis, Journal of Economic Inequality 7(3), 225-248.

[201] Powell, Robert, 1996, Bargaining in the shadow of power, Games and Economic Behavior 15(2), 255-289.

[202] Powell, Robert, 1999, In the shadow of power: States and strategies in international politics, Princeton: Princeton University Press.

[203] Powell, Robert, 2002, Bargaining theory and international conflict, Annual Review of Political Science 5(1), 1-30.

[204] Price, Curtis R., and Roman M. Sheremeta, 2011, Endowment effects in contests, Economics Letters 111(3), 217-219.

[205] Price, Curtis R., and Roman M. Sheremeta, 2015, Endowment origin, demographic effects and individual preferences in contests, Journal of Economics and Management Strategy 24(3), 597-619.

[206] Rabin, Matthew, and Dimitri Vayanos, 2010, The gambler's and hot hand fallacies: Theory and applications, Review of Economic Studies 77(2), 730-778.

[207] Reed, William, 2003, Information, power, and war, American Political Science Review 97(4), 633-641.

[208] Reinganum, Jennifer F., 1989, The timing of innovation: Research, development and diffusion. In: R. Schmalensee and R. Willig (eds.), Handbook of Industrial Organization, Elsevier. Volume 1, Chapter 14, 849-908.

[209] Robson, Alexander R. W., and Stergios Skaperdas, 2008, Costly enforcement of property rights and the Coase theorem, Economic Theory 36(1), 109-128.

[210] Rockenbach, Bettina, and Marcin Waligora, 2016, Desire to win drives overbidding in Tullock contests, Working Paper, http://dx.doi.org/10.2139/ssrn.2727153.

[211] Rosen, Sherwin, 1986, Prizes and incentives in elimination tournaments, American Economic Review 76(4), 701-715.

[212] Roth, Alvin E., and J. Keith Murnighan, 1982, The role of information in bargaining: An experimental study, Econometrica 50(5), 1123-1142.

[213] Runkel, Marco, 2011, Revenue sharing, competitive balance and the contest success function, German Economic Review 12(3), 256-273.

[214] Ryvkin, Dmitry, 2010, Contests with private costs: Beyond two players, European Journal of Political Economy 26(4), 558-567.

[215] Sachdev, Itesh, and Richard Y. Bourhis, 1987, Status differentials and intergroup behaviour, European Journal of Social Psychology 17(3), 277–293.

[216] Sachdev, Itesh, and Richard Y. Bourhis, 1991, Power and status differentials in minority and majority group relations, European Journal of Social Psychology 21(1), 1–24.

[217] Sánchez-Pagés, Santiago, 2007a, Endogenous coalition formation in contests, Review of Economic Design 11(2), 139-163.

[218] Sánchez-Pagés, Santiago, 2007b, Rivalry, exclusion, and coalitions, Journal of Public Economic Theory 9(5), 809-830.

[219] Sánchez-Pagés, Santiago, 2009, Conflict as a part of the bargaining process, Economic Journal 119(539), 1189-1207.

[220] Schaffer, Mark E., 1988, Evolutionary stable strategies for a finite population and a variable contest size, Journal of Theoretical Biology 132(4), 469-478.

[221] Schiller, Friedrich von, 1804, Wilhelm Tell, J. G. Cotta, Tübingen. Translation by Theodore Martin, 2007, Dodo Press.

[222] Schmalensee, Richard L., 1972, The economics of advertising, Amsterdam-London: North-Holland.

[223] Schmalensee, Richard L., 1978, A model of advertising and product quality, Journal of Political Economy 86(3), 485-503.

[224] Schneider, Gerald, and Ulrike Sabrina Krämer, 2004, The limitations of fair division: An experimental evaluation of three procedures, Journal of Conflict Resolution 48(4), 506-524.

[225] Shayo, Moses, and Asaf Zussman, 2011, Judicial ingroup bias in the shadow of terrorism, The Quarterly Journal of Economics 126(3), 1447-1484.

[226] Sheremeta, Roman M., 2010a, Expenditures and information disclosure in two-stage political contests, Journal of Conflict Resolution 54(5), 771-798.

[227] Sheremeta, Roman M., 2010b, Experimental comparison of multi-stage and one-stage contests, Games and Economic Behavior 68(2), 731-747.

[228] Sheremeta, Roman M., 2013, Overbidding and heterogeneous behavior in contest experiments, Journal of Economic Surveys 27(3), 491-514.

[229] Sheremeta, Roman M., 2016, Impulsive behavior in competition: Testing theories of overbidding in rent-seeking contests, Working Paper, http://papers.ssrn.com/abstract=2676419.

[230] Sheremeta, Roman M., and Jingjing Zhang, 2010, Can groups solve the problem of over-bidding in contests?, Social Choice and Welfare 35(2), 175-197.

[231] Sherif, Muzafer, O. J. Harvey, B. Jack White, William R. Hood, and Carolyn W. Sherif, 1961, Intergroup conflict and cooperation: The robber cave experiment, Norman, Oklahoma: University Books.

[232] Sieberg, Katri, David Clark, Charles Holt, Timothy Nordstrom and William Reed, 2013, An experimental analysis of asymmetric power in conflict bargaining, Games 4(3), 375-397.

[233] Skaperdas, Stergios, 1996, Contest success functions, Economic Theory 7(2), 283-290.

[234] Skaperdas, Stergios, 1998, On the formation of alliances in conflict and contests, Public Choice 96(1-2), 25-42.

[235] Skaperdas, Stergios, and Bernard Grofman, 1995, Modeling negative campaigning, The American Political Science Review 89(1), 49-61.

[236] Smith, Adam C., David B. Skarbek, and Bart J. Wilson, 2012, Anarchy, groups, and conflict: An experiment on the emergence of protective associations, Social Choice and Welfare 38(2), 325-353.

[237] Smith, Adam C., Daniel Houser, Peter T. Leeson and Ramin Ostad, 2014, The costs of conflict, Journal of Economic Behavior and Organization 97, 61-71.

[238] Sorokin, Gerald L., 1994, Arms, alliances, and security tradeoffs in enduring rivalries, International Studies Quarterly 38(3), 421-446.

[239] Stein, William E., 2002, Asymmetric rent-seeking with more than two contestants, Public Choice 113(3-4), 325-336.

[240] Sutter, Matthias, 2009, Individual behavior and group membership: Comment, American Economic Review 99(5), 2247-2257.

[241] Sutter, Matthias, Stefan Haigner, and Martin G. Kocher, 2010, Choosing the carrot or the stick? Endogenous institutional choice in social dilemma situations, Review of Economic Studies 77(4), 1540-1566.

[242] Sutter, Matthias, and Christina Strassmair, 2009, Communication, cooperation and collusion in team tournaments - An experimental study, Games and Economic Behavior 66(1), 506-525.

[243] Szidarovszky, Ferenc, and Koji Okuguchi, 1997, On the existence and uniqueness of pure Nash equilibrium in rent-seeking, Games and Economic Behavior 18(1), 135-140.

[244] Szymanski, Stefan, 2003, The economic design of sporting contests, Journal of Economic Literature 41(4), 1137-1187.

[245] Tajfel, Henri, 1982, Social psychology of intergroup relations, Annual Review of Psychology, 33(1), 1-39.

[246] Tajfel, Henri, and John Turner, 1979, An integrative theory of intergroup conflict. In: William Austin and Stephen Worchel (Eds.), The Social Psychology of Intergroup Relations, Monterey, CA, Brooks/Cole Publ., 33-48.

[247] Tammen, Ronald L., 2008, The Organski legacy: A fifty-year research program, International Interactions 34(4), 314-332.

[248] Tan, Guofu, and Ruqu Wang, 2010, Coalition formation in the presence of continuing conflict, International Journal of Game Theory 39(1-2), 273-299.

[249] Tsoulouhas, Theofanis, Charles R. Knoeber, and Anup Agrawal, 2007, Contests to become CEO: Incentives, selection and handicaps, Economic Theory 30(2), 195-221.

[250] Tullock, Gordon, 1980, Efficient rent seeking. In: James M. Buchanan, Robert D. Tollison, and Gordon Tullock (Eds.), Toward a Theory of the Rent-Seeking Society, Texas A&M University Press, 97-112.

[251] Umbeck, John, 1981, Might makes rights: A theory of the formation of initial distribution of property-rights, Economic Inquiry 19(1), 38-59.

[252] Ursprung, Heinrich W., 1990, Public goods, rent dissipation, and candidate competition, Economics and Politics 2(2), 115-132.

[253] Wagner, R. Harrison, 1994, Peace, war, and the balance of power, American Political Science Review 88(3), 593-607.

[254] Wadhwa, Monica, and JeeHye Christine Kim, 2015, Can a near win kindle motivation? The impact of nearly winning on motivation for unrelated rewards, Psychological Science 26(6), 701-708.

[255] Wagner, R. Harrison, 2000, Bargaining and war, American Journal of Political Science 44(3), 469-484.

[256] Wallensteen, Peter, and Isak Svensson, 2014, Talking peace: International mediation in armed conflicts, Journal of Peace Research 51(2), 315-327.

[257] Waltz, Kenneth N., 1979, Theory of international politics, McGraw-Hill.

[258] Wasser, Cédric, 2013, Incomplete information in rent-seeking contests, Economic Theory 53(1), 239-268.

[259] Wittman, Donald, 1979, How a war ends: A rational model approach, Journal of Conflict Resolution 23(4), 741-761.

[260] Wittman, Donald, 2009, Bargaining in the shadow of war: When is a peaceful resolution most likely?, American Journal of Political Science 53(3), 588-602.

[261] Wohlforth, William C., Richard Little, Stuart J. Kaufman, David Jang, Charles A. Jones, Victoria Tin-Bor Hui, Arthur Eckstein, Daniel Deudney and William L. Brenner, 2007, Testing balance-of-power theory in world history, European Journal of International Relations 13(2), 155-185.

[262] Wright, Quincy, 1965, A Study of War, Chicago: University of Chicago Press.