March, Christoph; Sahm, Marco

Working Paper

Contests as selection mechanisms: The impact of risk aversion

BERG Working Paper Series, No. 127

Provided in Cooperation with:
Bamberg Economic Research Group, Bamberg University

Suggested Citation: March, Christoph; Sahm, Marco (2017) : Contests as selection mechanisms: The impact of risk aversion, BERG Working Paper Series, No. 127, ISBN 978-3-943153-47-7, Bamberg University, Bamberg Economic Research Group (BERG), Bamberg

This Version is available at:
http://hdl.handle.net/10419/167673

Terms of use:
Documents in EconStor may be saved and copied for your personal and scholarly purposes.
You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.
If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.
Contests as Selection Mechanisms: 
The Impact of Risk Aversion

Christoph March and Marco Sahm

Working Paper No. 127
July 2017

Bamberg Economic Research Group
Bamberg University
Feldkirchenstraße 21
D-96052 Bamberg
Telefax: (0951) 863 5547
Telephone: (0951) 863 2687
felix.stuebben@uni-bamberg.de
http://www.uni-bamberg.de/vwl/forschung/berg/

ISBN 978-3-943153-47-7
Contests as Selection Mechanisms: The Impact of Risk Aversion

Christoph March\textsuperscript{a,b} \hspace{1cm} Marco Sahm\textsuperscript{c,b}
christoph.march@tum.de \hspace{1cm} marco.sahm@uni-bamberg.de

\textsuperscript{a}Technische Universität München, Arcisstraße 21, D–80333 Munich, Germany
\textsuperscript{b}CESifo, Poschingerstraße 5, D–81679 Munich, Germany
\textsuperscript{c}University of Bamberg, Feldkirchenstraße 21, D–96047 Bamberg, Germany

Abstract

We investigate how individual risk preferences affect the likelihood of selecting the more able contestant within a two-player Tullock contest. Our theoretical model yields two main predictions: First, an increase in the risk aversion of a player worsens her odds unless she already has a sufficiently large advantage. Second, if the prize money is sufficiently large, a less able but less risk averse contestant can achieve an equal or even higher probability of winning than a more able but more risk averse opponent. In a laboratory experiment we confirm both, the non-monotonic impact and the compensating effect of risk aversion on winning probabilities. Our results suggest a novel explanation for the gender gap and the optimality of limited monetary incentives in selection contests.

Keywords: Selection Contest; Risk Aversion; Competitive Balance; Gender Gap

JEL classification: C72, D72, J31, K41, M51, M52
1 Introduction

Contests are situations in which participants compete for some exogenous rent (prize) by spending non-refundable effort which increases their likelihood of winning (see e.g. Konrad, 2009). In environments where individuals’ abilities are not directly observable or verifiable, contests are frequently employed as mechanisms to select the most able candidate. Examples from all areas of life abound. To mention only a few, think of promotion contests in business, election campaigns in politics, or qualifying races in sports. It is well accepted that such contests involve a certain element of randomness (or “luck”). However, as the saying “May the best man win!” illustrates, employing contests as a selection device relies on the estimation that the most able contestant wins most of the time.

In fact, the winning probability of the most able measures how efficient the contest is as a selection mechanism. Unlike in rent seeking contests, the efficiency loss from employing scarce resources in an unproductive way while fighting over the rent plays a minor role in selection contests, because the rent itself is usually small compared to the social surplus that is generated afterwards by the selected candidate. Instead, the main inefficiency in selection contests usually arises due to the possibility that it does not select the most able contestant. For example, the (dissipated) premium in a promotion contest is small compared to the profit the respective firm forgoes by not selecting the most able manager and thereby staying below the production frontier. Similarly, the (dissipated) prize money in the olympic team trials is small compared to the positive externality society forgoes by not selecting the strongest athletes to represent their country.

The estimation that the most able has the highest winning probability is well-founded if contestants differ only in abilities (Tullock, 1980). Yet, contestants usually differ also in other aspects, like available resources (initial endowments), motivations (valuations of winning), or attitudes towards risk. With such additional heterogeneity between candidates, it becomes questionable whether the most able still wins most of the time. For example, Leininger (1993) and Baik (1994) show that a better motivated contestant may have better odds than a more able opponent. Similarly, we may ask whether higher readiness to assume risk can compensate for lower ability: Is the president-elect indeed best suited for holding office or just the candidate who had the courage to invest more money into the campaign? Is the winner of the famous Tour de France really the most talented cyclist or simply the athlete who fears least the negative health effects of high-performance sport? And (how) does it depend on the compensation scheme for managers whether promotion contests select competent experts or fearless gamblers, women or men?

In this paper, we aim to shed light on such questions, both theoretically and experimentally. To this end, we investigate the relative impact of individual abilities and risk preferences on the winning probabilities in simple two-person Tullock contests. Our experimental results confirm two theoretical predictions that are of particular interest. First, we observe that the impact of risk preferences on winning probabilities is non-monotonic: an increase in the risk aversion of a player worsens her odds unless her advantage (due to higher abilities or lower risk aversion) is sufficiently large. Second, we find a compensating effect: a less able but less risk averse contestant can achieve an equal or even higher probability of winning than a more able but more risk averse opponent if the prize is sufficiently large. The crucial role of the
prize, i.e. the rent from winning, has been largely neglected by the related literature so far but is intuitive: risk assessment plays a bigger role for higher stakes, and stakes increase in the prize.

In theory, the impact of risk preferences on the behaviour in contests is generally ambiguous (see e.g. Konrad and Schlesinger, 1997). This general ambiguity stems from two opposing effects induced by risk aversion (see e.g. Skaperdas and Gan, 1995): According to the gambling effect, a more risk averse participant has an incentive to invest less in the contest since doing so reduces his safe payment. On the other hand, investing more reduces the probability of losing which is why a more risk averse participant also has an incentive to invest more. This has been termed the self-protection effect. In general, it is not clear which of the two effects dominates. Moreover, the behaviour of risk averse contestants usually depends also on higher order risk attitudes like prudence (also referred to as downside risk aversion, see e.g. Treich, 2010). Empirical studies, however, find a positive correlation between prudence and risk aversion (see e.g. Noussair et al., 2014).

We thus restrict our theoretical analysis to examples from the class of preferences which exhibit such positive correlation. Specifically, we focus on contests with linear production functions for lotteries and participants with constant absolute risk aversion (CARA). This enables us to derive closed-form expressions for both, equilibrium efforts and winning probabilities, and to formally separate between the gambling effect and the self-protection effect.

Our model yields the following comparative statics: First and very intuitive, an agent’s probability of winning increases in his own ability level and decreases in his opponent’s ability level. Second, an agent’s probability of winning is either decreasing or inverted U-shaped (increasing or U-shaped) in his own (his opponent’s) degree of risk aversion. The potential non-monotonicity stems from the two opposing effects described above. The gambling effect, however, dominates the self-protection effect whenever the player’s advantage (due to higher abilities or lower risk aversion) is not too large. As this is, ceteris paribus, never the case if the player’s degree of risk aversion (and hence prudence) is sufficiently high, pronounced (downside) risk aversion always lowers the chance of winning.

Third, we characterise the Nash winner, i.e. the player with the higher probability of winning. As known from the literature, if participants only differ with respect to ability (risk preferences), the more able (less risk averse) participant has the higher probability of winning (see Baik, 1994, Skaperdas and Gan, 1995, Cornes and Hartley, 2003). It is then straightforward to see that the more able participant will always have the higher probability of winning if he is also less risk averse. However, in a contest between two participants, one of which has a higher ability (the gifted) while the other is less risk averse (the venturesome), two cases have to be distinguished. If differences in ability are predominant, the venturesome will never be the Nash winner and his winning probability decreases in the prize money. Intuitively, with predominance of differences in ability, risk considerations do not play a prominent role and, hence, participants behave as if they differed with respect to abilities only. By contrast, if differences in risk preferences are predominant, the venturesome is the Nash winner if and only if the prize money is sufficiently high. Moreover, his winning probability is U-shaped in the prize money. To gain some intuition for this result, note that risk considerations are not a big issue if stakes are low. Hence, for low rents, participants behave as if there was predominance of differences in abilities. However, as the prize money increases, the predominance of differences
in risk preferences becomes the decisive factor: Both participants increase their investments, but this increase is bigger for the less (downside) risk averse participant.

We validate the robustness of our predictions complementing our theoretical analyses with numerical simulations for contestants with constant relative risk aversion (CRRA). Qualitatively, the results confirm the validity of the comparative statics. Quantitatively, though, the impact of risk aversion is considerably smaller than for CARA preferences.

To test the comparative statics of the model empirically, we conduct an experiment in which subjects are repeatedly matched to compete in a two-player Tullock contest for a prize which is low at first and quintupled in the final contests. We implement two treatments with, respectively, symmetric and asymmetric contests. In the latter case, one of the subject’s effort is twice as effective as the other subject’s effort in each match. Finally, our design informs each subject in each match about (a proxy for) their opponent’s degree of risk aversion before efforts are selected.

Our results fully confirm three comparative statics of the model: First, the winning probability increases (decreases) as the own (the opponent’s) ability increases. Second, the winning probability is inverse U-shaped in the own degree of risk aversion. In particular, as predicted by the model, if and only if the winning probability is relatively high, it is increasing in the own degree of risk aversion. Third, the probability of winning is increasing in the opponent’s degree of risk aversion.

Though we also confirm that the winning probability of the venturesome is increasing in the size of the prize money, the increase is small and not significant if he is also the less able contestant. Moreover, the venturesome is never the Nash winner in our experiment, not even if the prize is high. However, our results suggest that lower risk aversion can compensate lower ability to some degree. Accordingly, an even higher prize might favor the venturesome sufficiently to become the Nash winner (on average).

The remainder of this article is organised as follows: In Section 2, we explain the relation and contribution to the existing literature. Section 3 contains our theoretical analyses. In Section 4, we summarise our experimental design and procedures. The experimental results are presented in Section 5. In Section 6, we discuss several applications of our findings which offer, for example, a novel explanation for the gender gap and the optimality of limited monetary incentives in selection contests. Section 7 concludes. An online-appendix contains supplementary material with the proofs, complementary theoretical and statistical results, and the experimental instructions.

2 Related Literature

In this section, we briefly review the related literature on risk preferences in contests and highlight our theoretical and experimental contributions.
2.1 Theoretical Contributions

Relatively few theoretical papers explicitly address the role of risk preferences in contests. Most of them assume homogeneous players and focus on aggregate effort (rent dissipation). In general, the influence of risk aversion on aggregate effort in symmetric contests with a finite number of players and general contest success functions is ambiguous (Konrad and Schlesinger, 1997). However, the aggregate effort of risk averse participants will be lower than the aggregate effort of risk neutral players if the participants are also prudent (Millner and Pratt, 1991, Treich, 2010). For contests with many participants (Hillman and Katz, 1984, Cornes and Hartley, 2012) or certain conditions on the participants’ comparative prudence (Sahm, 2017), this result generalises in the sense that rent dissipation is the smaller the higher the participants’ common level of risk aversion.

Whereas all these papers examine how changes in common risk preferences influence aggregate behaviour and rent dissipation across contests, we ask how differing risk preferences affect individual behaviour and winning probabilities within a given contest. This question has not yet been addressed in the literature for general risk preferences but only for the specific cases of CARA (Skaperdas and Gan, 1995, Cornes and Hartley, 2003) and CRRA (Bozhinov, 2006), both of which imply prudence. Among other things, these articles show that, ceteris paribus, the less risk averse of any two participants exerts more effort and, therefore, has the better chance of winning.

Taking this result as a basis, our theoretical analysis advances the studies of lottery contests between participants with asymmetric CARA-preferences by Skaperdas and Gan (1995) and Cornes and Hartley (2003) in several respects. First, while they focus on the role of risk aversion for effort provision and rent dissipation, we emphasise its impact on winning probabilities and the consequences for contest design. Second, we consider a second source of heterogeneity assuming differing abilities. This allows to study the interplay of two asymmetric individual characteristics which gives rise to our main results: the potentially non-monotonic impact and the compensating effect of risk aversion on winning probabilities. Finally, we are more specific about the contest success functions assuming linear production functions for lotteries. This allows for an original and comprehensive comparative statics analysis with respect to both, the players’ characteristics (ability and risk aversion) and the contest design (prize money), and generates testable hypotheses for our experimental inspection.

2.2 Experimental Contributions

Our paper also contributes to a large and growing experimental literature on contests (Dechenaux et al., 2015, Sheremeta, 2013). So far, this literature has mainly focused on overbidding and overspreading, i.e. the tendency of efforts to be considerably higher than Nash equilibrium predictions and strongly dispersed. Most closely related to this paper are studies which investigate asymmetric contests in which contestants differ with respect to at least one characteristic, in

\footnote{Note the difference to the models of Hvide (2002) and Hvide and Kristiansen (2003), in which players have the same attitude towards risk ex-ante but where risk taking is a strategic variable that is endogenously determined in the equilibrium of the contest.}

\footnote{Though in principle Cornes and Hartley (2003) accommodate differences in both abilities and attitudes towards risk, most of their related results (e.g. Propositions 3.4 and 5.1) rest upon the additional assumption of participants being homogeneous with respect to abilities.}
A major focus of experimental papers studying contestants with heterogeneous abilities is the *discouragement effect*, the theoretical prediction that asymmetries lead to lower individual and aggregate effort. Intuitively, if an agent feels disadvantaged, he might be discouraged and reduce his effort which, in turn, induces his opponent to reduce his effort as well. The experimental evidence by and large confirms the discouragement effect (e.g. Fonseca, 2009, Anderson and Freeborn, 2010, Kimbrough et al., 2014). March and Sahm (2017) discusses the contribution to this literature in greater detail.

Experimental studies which consider risk preferences mainly study the impact on efforts. Despite the ambiguous theoretical predictions, most of these studies find that risk aversion significantly reduces mean individual effort (e.g. Millner and Pratt, 1991, Anderson and Freeborn, 2010, Sheremeta, 2011). As our theoretical analysis will show (cf. Proposition 3), the impact of differences in risk preferences depends on their interplay with other individual (e.g. abilities) and institutional (e.g. the rent) characteristics. However, only very few experimental papers have addressed the interaction between risk preferences and further characteristics so far. One exemption is the interaction between risk aversion and gender. Though empirical studies usually find that women are more risk averse than men (Croson and Gneezy, 2009), the experimental evidence on the impact of gender on effort in contests is mixed. While Anderson and Freeborn (2010) find that women exert less effort than men, even if controlling for risk aversion, Price and Sheremeta (2015) and Mago et al. (2013) report the opposite.

Our paper contributes to the experimental literature on contests in several ways: First, we consider contests with two-dimensional heterogeneity. Second, we analyse the impact of varying the prize money. Third, we explicitly inform subjects about their opponent’s degree of risk aversion. Finally, we rather focus on winning probabilities than effort provision.

3 Theory

In this section, we first introduce the basic contest game with (potentially) asymmetric abilities. We then analyse the influence of contestants’ characteristics (abilities and risk preferences) and the size of the rent (prize money) on the competitive balance for contestants with CARA-preferences. Finally, we numerically confirm these comparative statics for contestants with CRRA-preferences.

3.1 The Basic Contest with Heterogeneous Abilities

Two participants $i \in \{1, 2\}$ compete in a winner-take-all contest for a rent of size $R > 0$. Each participant $i \in \{1, 2\}$ has an initial wealth endowment $e_i \in \mathbb{R}_+$ and can invest some effort $x_i \in [0, e_i]$ in order to improve his probability of winning $p_i$. Given effort levels $x_i$ and $x_j$ for...
\( j \neq i \), this probability will equal \( p_i := 1/2 \) if \( x_i = x_j = 0 \), and

\[
p_i := \frac{\theta_i x_i}{\theta_i x_i + \theta_j x_j}, \tag{1}\]

if \( x_i + x_j > 0 \), where \( \theta_i > 0 \) is a parameter expressing participant \( i \)'s ability. Note that this formulation reflects, reasonably enough, a complementarity between ability and effort, which is standard in the related literature (e.g. Leininger, 1993, Baik, 1994).\(^5\) Without loss of generality, let participant 1 be at least as talented as participant 2, i.e. \( \theta_1 \geq \theta_2 \).

Participants are assumed to maximise their expected utility. The utility \( u_i(z) \) participant \( i \in \{1, 2\} \) derives from a certain wealth level \( z \) can be expressed by means of some three times continuously differentiable function \( u_i : \mathbb{R} \rightarrow \mathbb{R} \) with \( u''_i \leq 0 < u'_i \).

The contest is organised as a simultaneous move game with complete information. Each participant knows his own as well as his opponent’s characteristics. Given effort \( x_i \), participant \( i \)'s wealth equals \( W_i := e_i - x_i + R \) if he wins the contest and \( L_i := e_i - x_i \) otherwise. Hence, for \( i, j \in \{1, 2\}, i \neq j \),

\[
E u_i = p_i u_i(W_i) + (1 - p_i) u_i(L_i)
= \frac{\theta_i x_i}{\theta_i x_i + \theta_j x_j} u_i(e_i - x_i + R) + \frac{\theta_j x_j}{\theta_i x_i + \theta_j x_j} u_i(e_i - x_i).
\]

Cornes and Hartley (2012, Theorem 3.1) show that under these assumptions a Nash equilibrium in pure strategies always exists. Moreover, they derive some regularity condition on the curvature of the utility functions \( u_i \) under which the Nash equilibrium is unique (Cornes and Hartley, 2012, Theorem 4.2). Yamazaki (2009) shows that, under the assumptions made, the Nash equilibrium in pure strategies will be unique if the Arrow-Pratt measure of absolute risk aversion \( RA(u_i, z) = -\frac{u''_i(z)}{u'_i(z)} \) is non-increasing in the wealth level \( z \) for all participants \( i \).

All these results hold even for the more general case of a contest between an arbitrary number \( n \in \mathbb{N} \) of participants and includes the possibility that some of them might be inactive in equilibrium, i.e. exert zero effort. However, in any equilibrium of a two-player contest, both players will obviously exert positive effort. The corresponding effort levels will hence be fully characterised by the two first order conditions (FOC) for maximum expected utilities:

\[
\frac{\partial p_i}{\partial x_i} = \frac{p_i u'_i(W_i) + (1 - p_i) u'_i(L_i)}{u_i(W_i) - u_i(L_i)}. \tag{2}\]

### 3.2 Comparative Statics for Contestants with CARA-Preferences

Similar to Skaperdas and Gan (1995) and Cornes and Hartley (2003), respectively, we first assume that the preferences of participant \( i \) can be expressed by the following utility function which exhibits CARA:

\[
u_i(z_i) := \frac{1 - e^{-\alpha_i z_i}}{\alpha_i}.
\]

\(^5\)The resulting type of asymmetric contest success function was given an axiomatic foundation by Clark and Riis (1998), following an earlier axiomatisation of the symmetric form with \( \theta_1 = \theta_2 \) by Skaperdas (1996).
is participant i’s constant degree of absolute risk aversion. We restrict the theoretical analysis to risk averse participants, i.e. \( \alpha_i > 0 \). Asymptotically, this includes risk neutrality since \( u_i(z_i) \to z_i \) as \( \alpha_i \to 0 \).

Under these assumptions, the rent seeking game has a unique Nash equilibrium in pure strategies (see Cornes and Hartley, 2003, Proposition 3.3 and Yamazaki, 2008). For ease of notation, define

\[
\beta_i \equiv \beta(\alpha_i) := \frac{\alpha_i}{1 - e^{-\alpha_i R}} > \alpha_i > 0, \tag{4}
\]

\[
\delta_i \equiv \delta(\alpha_i) := \frac{\alpha_i e^{-\alpha_i R}}{1 - e^{-\alpha_i R}} = e^{-\alpha_i R} \beta_i = \beta_i - \alpha_i > 0. \tag{5}
\]

Using the identity \( e^X = \sum_{k=0}^{\infty} \frac{X^k}{k!} \) for any real \( X \), it is easily verified that \( \beta_i (\delta_i) \) is increasing (decreasing) in \( \alpha_i \) (Skaperdas and Gan, 1995, supplementary appendix to Proposition 2). Given the uniqueness of the equilibrium, the necessary FOC for an interior solution of participant i’s maximisation problem is also sufficient and yields

\[
p_i' = \beta_i \left( p_i e^{-\alpha_i R} + 1 - p_i \right), \tag{6}
\]

where \( p_i' := \partial p_i / \partial x_i \geq 0 \). Equation (6) implicitly defines the reaction function of participant i, i.e. his optimal effort \( x_i \) as a function of the opponent’s effort \( x_j \). Dividing condition (6) of participant 1 by condition (6) of participant 2 and noting that \( \frac{p_1'}{p_2'} = \frac{x_2}{x_1} \) yields

\[
\frac{\theta_1}{\theta_2} q = \frac{\beta_1}{\beta_2} \cdot \frac{e^{-\alpha_1 R} + q}{q e^{-\alpha_2 R} + 1}, \tag{7}
\]

where \( q := \frac{p_2}{p_1} = \frac{\theta_2 x_2}{\theta_1 x_1} \) is called the competitive balance of the contest.\(^6\) A value \( q < 1 \) indicates that participant 1’s probability of winning exceeds the one of participant 2, i.e. \( p_1 > p_2 \), and vice versa for \( q > 1 \). If \( q = 1 \), the contest will be called even. Notice that the equilibrium competitive balance \( q \) is a function of both, the contestants’ characteristics (abilities \( \theta_1, \theta_2 \), and risk aversions \( \alpha_1, \alpha_2 \)) and the contest designer’s choice of the prize money \( R \).

In Appendix A, we provide closed form solutions of the competitive balance and the individual efforts in equilibrium. For the subsequent analysis, however, it is more convenient to rewrite equation (7) as follows:

\[
\frac{\theta_2}{\theta_1} = q \cdot \frac{(1 + q) \beta(\alpha_2) - q \alpha_2}{(1 + q) \beta(\alpha_1) - \alpha_1} =: \Phi(q, \alpha_1, \alpha_2, R). \tag{8}
\]

The right hand side of equation (8) is a function \( \Phi \) of \( q, \alpha_1, \alpha_2 \), and \( R \) but independent from abilities. It shows that \( q \) depends, ceteris paribus, only on the ratio of abilities but not on their exact values.\(^7\)

---

\(^6\)Some authors use the difference in winning probabilities as an alternative measure of competitive balance or closeness of the contest (see e.g. Runkel, 2006a,b).

\(^7\)Hence, without loss of generality, \( \theta_1 \) might be normalised to 1.
As intuition suggests and comparative statics with respect to abilities show, being more able always redounds to the contestant’s advantage. This follows immediately from the fact that the right hand side of equation (8) is strictly increasing in $q$ (cf. Appendix B).

**Proposition 1.** The participant’s probability of winning is strictly increasing (decreasing) in the own (opponent’s) ability, i.e. \( \frac{\partial p}{\partial q_1} < 0 < \frac{\partial p}{\partial q_2} \).

Skaperdas and Gan (1995, Proposition 2b), Cornes and Hartley (2003, Proposition 3.4), and Bono (2008, Proposition 1) show that of any two equally able participants, the one with the lower degree of constant absolute risk aversion invests more into the contest and thus has a higher probability of winning. These results might provoke the impression that the winning probability of a contestant always is the higher the less risk averse he is. However, in general such an impression is false. Whether an increase in the participant’s degree of risk aversion is in his favour or not depends on whether the gambling effect or the effect of self protection prevails, which in turn depends on the competitive balance of the contest. Hence, the relation between the participant’s degree of risk aversion and his winning probability may be non-monotonic.

**Proposition 2.** The participant’s probability of winning is ceteris paribus

(a) either decreasing or inverted U-shaped in the own degree of risk aversion,

(b) either increasing or U-shaped in the opponent’s degree of risk aversion.

The proof can be found in Appendix B. Note that, since abilities are fixed, any change in the competitive balance results from a corresponding change in the participants’ relative effort $\xi := \frac{x_2}{x_1} = \frac{\theta_1}{\theta_2} q$ in equilibrium. To get an intuition for the possible non-monotonicity, it is helpful to disentangle the two opposing effects considering, for instance, a marginal increase of participant 2’s degree of risk aversion. On the one hand, self-protection refers to the effect that increasing risk aversion intensifies the participant’s incentives to invest into the contest in order to protect his inframarginal investments. As a result, his winning probability increases. On the other hand, gambling refers to the effect that increasing risk aversion lowers the participant’s incentives to invest into the contest constituting a risky lottery. As a result, his winning probability decreases.

In the proof (cf. equation (B.3) in Appendix B), we show that the relative strength of these two effects is scaled by the actual competitive balance: If the participant’s winning probability is high, the riskiness of the contest as perceived by the participant will be relatively low. Hence, the gambling effect will be relatively weak and the effect of self protection will dominate. Inverse reasoning applies if the participant’s probability of winning is relatively low. Summing up, the participant’s probability of winning is increasing in the own degree of risk aversion if and only if his own probability of winning is relatively high, i.e. if the competitive balance $q$ exceeds some threshold $q_2$.

However, the threshold itself depends on the participant’s risk aversion (cf. Lemma 3 in Appendix B): The more risk averse the contestant is, the higher his winning probability must be for the self-protection effect to prevail. Put differently, the threshold $q_2$ is an increasing function of $\alpha_2$ as depicted in Figure 1. Now, increasing the participant’s risk aversion starting
from $\alpha_2 = 0$, two cases may arise: If his winning probability is low even initially (e.g. due to some disadvantage in abilities), then the gambling effect will always dominate and his winning probability will be monotonically decreasing. However, if his winning probability is initially high (e.g. due to some advantage in abilities), the self-protection effect will dominate up to some level of risk aversion $\alpha_2^{\text{max}}$ from which on the critical threshold $q_2$ exceeds the actual competitive balance $q$ (cf. Figure 1). Thus, the participant’s probability of winning will be inverted U-shaped in the own degree of risk aversion.

3.2.2 The role of contest design: choosing the rent

Contests are designed for various objectives. Some objectives directly tend to the odds ratio. For example, a promotion contest might want to maximise the winning probability of the most able while a sports contest might want to equalise the competitive balance. In this subsection, we investigate how the contest designer can influence the equilibrium winning probabilities by choice of the rent $R$. Two questions are of particular interest: First, depending on the rent, who is the Nash winner, i.e. who has the better odds in equilibrium (Baik, 1994)? Second, how do the odds change by a change in the rent?

Addressing these questions, we generalise the results from the existing literature to contests between participants that differ in both, ability and risk aversion. If both participants have the same degree of risk aversion, the more able participant will be the Nash winner (Baik, 1994, Lemma 2). If both players have the same ability, the less risk averse player will be the Nash winner (Cornes and Hartley, 2003, Proposition 3.4). Combining these results, it is straightforward to see that the more talented player will always be the Nash winner if he is also less risk averse.

We can thus restrict the further analysis to cases in which participant 1 has a higher ability and, at the same time, a higher degree of risk aversion than participant 2.8 Who will be the Nash winner then depends on whether the difference in abilities or the difference in degrees of risk aversion is more pronounced. The following definitions will simplify the exposition. The contest is said to exhibit predominance of heterogeneity in abilities if the relative difference in abilities measured by the ratio $\frac{\theta_1}{\theta_2}$ is at least as big as the relative difference in degrees of

---

8Sometimes participant 1 will be called the *gifted* and participant 2 will be called the *venturesome* in such a case.
risk aversions measured by the ratio $\frac{\alpha_1}{\alpha_2}$. To the contrary, if $\frac{\theta_1}{\theta_2} < \frac{\alpha_1}{\alpha_2}$ the contest is said to exhibit *predominance of heterogeneity in risk aversion*. As the main result of this subsection, Proposition 3 characterises the Nash winner depending on the rent $R$ and provides the respective comparative statics.

**Proposition 3.** Suppose $\theta_1 > \theta_2 > 0$ and $\alpha_1, \alpha_2 > 0$.

(a) Predominance of heterogeneity in abilities: If $\frac{\theta_1}{\theta_2} \geq \frac{\alpha_1}{\alpha_2}$, then for all $R > 0$:

(i) $q < \frac{\theta_2}{\theta_1} < 1$,

(ii) $\frac{\delta q}{\delta R} < 0$.

(b) Predominance of heterogeneity in risk aversion: If $\frac{\theta_1}{\theta_2} < \frac{\alpha_1}{\alpha_2}$, then there exist cut-off values $0 < R_0 < R_1$ such that

(i) $q \geq 1 \iff R \geq R_1$ (with equality if and only if $R = R_1$),

(ii) $\frac{\delta q}{\delta R} \geq 0 \iff R \geq R_0$ (with equality if and only if $R = R_0$).

The proof can be found in Appendix B. Part (a) of Proposition 3 states that if differences in abilities predominate differences in risk aversion, the winning probability for the gifted will always be higher than for the venturesome. Moreover, a higher prize further increases the chance of winning for the participant with the higher ability. Since abilities are fixed, any change in the competitive balance results from a corresponding change in the participants’ relative effort $\xi := \frac{x_2}{x_1} = \frac{\theta_2}{\theta_1} q$. Accordingly, $\xi < 1$, i.e. the gifted will exert more effort in equilibrium. Moreover, as the rent rises, the increase in his winning probability results from an increase in his relative equilibrium effort. Intuitively, due to risk aversion, the less able participant with the worse odds expands his effort more slowly than the more able participant with the better odds.\(^9\)

As part (b) of Proposition 3 shows, things are slightly more complicated with predominance of heterogeneity in risk aversion. In this case, again the winning probability for the gifted will be higher than for the venturesome (and increasing) if the rent is sufficiently small. However, if the rent exceeds a certain threshold, the opposite will be true: the winning probability for the venturesome will be higher than for the gifted (and increasing). Figure 2 illustrates these results.

To get an intuition, notice that for low rents, risk considerations do not play much of a role and ability differences are the predominant factor (c.f. Lemma 4 in Appendix B). However, as the rent increases, differences in risk preferences become more and more important. This has several reasons. The rising rent ceteris paribus increases both, the mean $I_i - x_i + p_i R$ and the variance $p_i (1 - p_i) R^2$ of player $i$’s lottery associated with the contest. The higher mean provides an incentive to invest more but the higher variance weakens this incentive for risk averse players. Moreover, the induced higher investment comes along with two second-order effects of a rising rent: First, the lottery takes place at a lower wealth level $I_i - x_i$ which further weakens the

\(^9\)If players are risk neutral, their investments coincide such that the equilibrium competitive balance equals $q = \frac{\theta_2}{\theta_1}$ and does, apparently, not depend on the rent $R$. This neutrality result is due to Runkel (2006a, Proposition 1 (b)) and also holds for a slightly more general class of Tullock contest success functions. As Proposition 3 shows, it will break down if players are risk averse.
additional investment incentive for prudent, i.e. downside risk averse players (Treich, 2010). Second, depending on the winning probability, the higher investment will ceteris paribus either further increase the variance if \( p_i < 1/2 \) or decrease it if \( p_i > 1/2 \) (Eeckhoudt and Gollier, 2005). Summing up, the additional investment incentives for the gifted, i.e. the more risk averse and prudent player are strongest when the rent is low and he is the Nash winner but weaken as the rent rises. Consequently, from a certain threshold \( R_0 \) on, the winning probability of the venturesome starts to increase as the rent becomes higher, because – from this point on – the gifted increases his investment by relatively less than the venturesome. This process continues such that the effort of the venturesome exceeds the effort of the gifted as the rent rises above some threshold \( \bar{R} \in (R_0, R_1) \), and his winning probability exceeds the winning probability of the gifted as the rent rises above \( R_1 \).

A comparison of the positive results of Proposition 3 (a) and (b) highlights the problem of normative contest design in the presence of heterogeneous participants who may differ in more than one dimension. Depending on the contestants’ characteristics, the very same design may lead to diametrically opposed outcomes. For the example at hand, a sufficiently high rent will guarantee a winning probability arbitrarily close to one either to the gifted if differences in abilities are predominant or to the venturesome if differences in risk preferences are predominant. This sensitivity turns contest design into a non-trivial task. In order to achieve a certain goal, the designer has to adapt the structure of the contest to the pool of contestants. The following two examples illustrate this necessity.

First, suppose the designer wants to maximise the winning probability of the gifted. This is a plausible goal for many selection contests such as qualifying races in sports or recruitment tests in human resource management. With predominance of heterogeneity in abilities, part (a) of Proposition 3 implies that the contest designer achieves his aim the better the higher the rent he offers. However, with predominance of heterogeneity in risk aversion, he should restrict the prize money to \( R_0 \) according to part (b) of Proposition 3. Put differently, with predominance of differences in risk preferences, there is scope for the limitation of monetary incentives, but not so with predominance of heterogeneity in abilities.

Second, assume the designer wants to implement an even contest. This is a plausible as-

\[ Figure 2 \] \( q \) as a function of \( R \) for \( \theta_1 = 1, \theta_2 = \frac{1}{2}, \alpha_1 = 1, \) and \( \alpha_2 = \frac{1}{4} \)

---

10Note that selection contests may have other goals as well, e.g. maximising the winning probability of the selected in a subsequent contest. However, selecting the most able is optimal whenever the selector is able to insure the selected against subsequent risks.
umption whenever the closeness is a productive input or, more generally, exerts some positive externality the designer would like to internalise. For example, a well-balanced sports tournament may – besides the contestants’ effort – attract more viewers and promote the organiser’s sales of tickets as well as television and sponsorship contracts. Similarly, a political system that leads to close elections may involve more people into the democratic process. With predominance of heterogeneity in abilities, part (a) of Proposition 3 implies that the contest designer achieves his aim the better the lower the rent he offers. However, with predominance of heterogeneity in risk aversion, he should choose a prize money of $R_1 > 0$ according to part (b) of Proposition 3. Put differently, with predominance of heterogeneity in abilities, the trade-off between balancing the contest and incentivising the contestants’ effort is much more pronounced than with predominance of differences in risk preferences.

3.3 Robustness Issues

In this section, we briefly discuss whether the qualitative results of the previous section remain valid for contests with more than two players, more general contest success functions, and different risk preferences.

3.3.1 More than two participants

The two-player-model is relevant for many real world contests like duels in sports, competition between political parties, or litigation in court. Nevertheless, other applications require to consider a contest between an arbitrary number $n \in \mathbb{N}$ of participants. The contest success function of player $i \in \{1, \ldots, n\}$ is then given by $p_i := \frac{\theta_i x_i}{\sum_{j=1}^{n} \theta_j x_j}$, his degree of constant absolute risk aversion is denoted by $\alpha_i$. It is straightforward to show that the participants’ winning probabilities in equilibrium are, analogously to equation (8), implicitly defined by a system of equations of the following form:

$$\frac{\theta_j}{\theta_k} = \frac{(1 + q_j) \beta(\alpha_j) - q_j \alpha_j}{(1 + q_k) \beta(\alpha_k) - q_k \alpha_k},$$

where $q_i := \frac{p_i}{\sum_{i=1}^{n} p_i}$ is player $i$’s relative chance of winning. With more than two participants, the comparative statics become obviously more involved because an increase in $q_j$ does not necessarily imply a decrease in $q_k$ a priori due to possible effects on third parties. However, the equilibrium conditions have a very similar structure and the opposing effects of gambling and self protection associated with risk aversion can be identified here as well. To see this, define $\phi_i(q_i, \alpha_i) := (1 + q_i) \beta(\alpha_i) - q_i \alpha_i$. As in the proof of Lemma 2 (cf. Appendix B), the implicit function theorem yields

$$\frac{dq_j}{d\alpha_j} = -\frac{\partial \phi_j}{\partial \alpha_j} \frac{\partial \phi_j}{\partial q_j} + \frac{\phi_j \partial \phi_k}{\partial \phi_j} \frac{\partial \phi_k}{\partial q_j} \frac{dq_k}{d\alpha_j}.$$

Roughly speaking, the second term in the sum on the right hand side captures the effects that are due to the reaction of other players, and has the same sign as $\frac{dq_k}{d\alpha_j}$. Whereas the first term captures the effect that is due to a change in player $j$’s own behaviour. This term has the opposite sign of $\partial \phi_j/\partial \alpha_j$, since $\frac{\partial \phi_j}{\partial \alpha_j} = \delta(\alpha_j) > 0$. However, as in equation (B.3) in Appendix B,
the sign of
\[
\frac{\partial \phi_j}{\partial \alpha_j} = q_j \frac{\partial \delta_j}{\partial \alpha_j} + \frac{\partial \beta_j}{\partial \alpha_j}
\]
depends on the relative strength of the self-protection effect represented by \(\frac{\partial \delta_j}{\partial \alpha_j} < 0\) and the gambling effect represented by \(\frac{\partial \beta_j}{\partial \alpha_j} > 0\).

Therefore, the basic results for a contest with an arbitrary number of participants should qualitatively be in line with those derived for two players.

### 3.3.2 General contest success functions

Consider the model described in Section 3.2 but with the more general contest success function

\[
p_i := \frac{f_i(x_i)}{f_1(x_1) + f_2(x_2)},
\]

where \(f_i : \mathbb{R}^+ \to \mathbb{R}^+\) is a twice continuously differentiable function of \(x_i\) satisfying \(f''_i \leq 0 < f'\) and \(f_i(0) = 0\). Moreover, assume that the contest game has a unique Nash equilibrium in pure strategies.\(^{11}\) Then it is straightforward to show that, analogously to equation (8), the competitive balance in equilibrium is implicitly defined by

\[
\frac{f'_2(x_2)}{f'_1(x_1)} = q \cdot \frac{(1 + q) \beta(\alpha_2) - q \alpha_2}{(1 + q) \beta(\alpha_1) - \alpha_1}.
\]

Comparing (8) and (10), observe that the right hand sides of both equations are identical and the left hand sides both express the ratio of the participants’ marginal productivities. The only difference is that these marginal productivities and, hence, their ratio are constant for linear production functions, whereas in the general case the marginal productivities depend on equilibrium efforts. Consequently, though the comparative statics become more involved, the identification of the Nash winner along the lines of inequality (B.5) in Appendix B and the conclusions drawn from that carry over to a model with more general contest success functions: Whether the gifted or the venturesome has the better chance of winning depends on a comparison between relative differences in marginal productivities and degrees of risk aversion.

### 3.3.3 Numerical results for contestants with CRRA-preferences

The case of CARA-preferences analysed in Section 3.2 may be understood as an example for the empirically relevant class of risk preferences for which the correlation between risk aversion and prudence is positive and the less risk averse ceteris paribus has the better chance of winning. We thus conjecture that our results carry over to contests with more general risk preferences within this class. The conjecture finds support by observations from contestants with CRRA-

\(^{11}\)A sufficient condition is, for example, that \(f_i\) is concave and \(f_i(0) = 0\) for \(i \in \{1, 2\}\) (Cornes and Hartley, 2003). Moreover, note that the model with nonlinear production functions for lotteries and linear effort costs is equivalent to a model with linear production functions for lotteries and nonlinear effort costs.
preferences. The utility of player \( i \) then equals

\[
u_i(z_i) := \frac{z_i^{1-r_i}}{1-r_i},\]

where \( 0 < r_i < 1 \) denotes his constant degree of relative risk aversion. Note that in this case the player is also prudent with a constant degree of relative prudence \( 1 + r_i \). Bozhinov (2006) specifies conditions under which a unique Nash equilibrium exists in the CRRA-case. Given that the conditions are met, straightforward calculations show that for equal endowments \( I_1 = I_2 = I \), the first order conditions for optimal effort provision yield

\[
\left( \frac{I - x_i + R}{I - x_i} \right)^{-r_i} = \frac{(I - x_i)\theta_i\theta_jx_j + \theta_jx_j[\theta_i x_i + \theta_j x_j](1 - r_i)}{(I - x_i + R)\theta_i\theta_jx_j - \theta_i x_i[\theta_i x_i + \theta_j x_j](1 - r_i)}
\]

with \( i, j \in \{1, 2\}, i \neq j \). Based on the equilibrium conditions, we have numerically calculated efforts and winning probabilities for a large number of parameter constellations. The results are presented in Appendix C.

The numerical results qualitatively confirm the main results for CARA-preferences: Higher abilities are always an advantage (Proposition 1). Figures C.2(c) and C.4(b) in Appendix C, respectively, illustrate that the winning probability may be non-monotonic in the own and the opponent’s degree of risk aversion (Proposition 2). And Figures C.5 and C.6 in Appendix C illustrate that comparative statics with respect to the rent lead to diametrical results depending on whether differences in abilities or risk preferences prevail (Proposition 3). Quantitatively, however, the impact of risk aversion with CRRA-preferences is usually less pronounced than with CARA-preferences.

4 Experimental Design and Procedures

We test the theoretical predictions derived in Section 3 with the help of an experiment. This enables us to investigate the influence of contestants’ characteristics and the size of the rent under controlled ceteris paribus conditions. In this section, we describe the design and procedures of the experiment. The experimental results are presented in Section 5.

4.1 General Features

We conduct various sessions in which subjects play 30 repetitions of the basic contest game described in Section 3. In each repetition, subjects are randomly matched into pairs and each subject receives an endowment of \( e_i = 600 \) points. Subjects may invest this endowment to obtain lottery tickets. The lottery’s prize varies across repetitions. Specifically, subjects compete for a prize of size \( R = 200 \) points in the first 20 repetitions and for a prize of size \( R = 1,000 \) points in the last 10 repetitions.

Risk preferences are measured at the beginning of the experiment.\(^{13}\) We employ a multiple

\(^{12}\)The observation that, as participant 2’s degree of risk aversion \( r_2 \) increases from zero to some small positive value, his winning probability may either rise or fall, depending on the ability ratio \( \theta_2/\theta_1 \), is made also by Hughes and Woglom (1996, Lemmas 3 and 4) who consider a contest between a risk neutral participant 1 and a risk averse participant 2 with CRRA.

\(^{13}\)Obviously, this design feature relies on the assumption that risk-preferences are not context-dependent.
price list format (see e.g., Holt and Laury, 2002). Each subject is presented with a table of ten ordered decisions between a safe amount of 180 points and a risky lottery which offers either 400 points or 0 points. Across the table, the likelihood of receiving the 400 points increases from 0.1 in the first row to 1.0 in the last row in steps of 0.1 (hence, the probability of receiving the 400 points in row $k$ equals $k/10$). Subjects are required to select one of the options in each row (we did not allow for indifference). For a subject who maximizes expected utility and has a strictly increasing utility function, there exists a unique row such that the subject chooses the risky lottery in this and all subsequent rows and the safe amount in all previous rows. The subject’s risk preferences may thus be summarised by the number of times he chooses the safe lottery. In the experimental instructions, probabilities are explained in terms of throws of a ten-sided dice.

In contrast to risk preferences, abilities are induced by assigning each subject an ability level $\theta_i \in \{1, 2\}$ where $\theta_i$ denotes the amount of lottery tickets obtained for each point invested. We implemented two treatments which differ in the assignment of abilities. In treatment Symmetric, each subject is assigned the ability level $\theta_i = 1$ in each repetition. Accordingly, differences in ability are absent which enables us to focus on the impact of differences in risk aversion on effort levels and probabilities of winning. In treatment Asymmetric, one subject in each pair is assigned the high ability level $\theta_i = 2$, while the other subject is assigned the low ability level $\theta_j = 1$ ($j \neq i$). To provide learning opportunities, a subject is assigned the same ability level for the first half of repetitions with a given prize and switches to the other level for the second half. More precisely, we employ a median split of all participants in a given session according to the number of times subjects choose the safe amount at the beginning of the experiment. Subjects in the more (less) risk averse group are then assigned the low (high) ability in repetitions 1 to 10 and 21 to 25 and the high (low) ability in repetitions 11 to 20 and 26 to 30.

Finally, since our theoretical benchmark assumes complete knowledge of abilities and risk preferences, we aim to approximate the latter as close as possible. Therefore, before a subject chooses his effort in a given repetition, we remind him of his own and his opponent’s assigned ability level, and we also inform the subject about the number of times he and his opponent selected the safe amount in the multiple price list.

4.2 The Progress of a Session

Each experimental session is partitioned into three parts. Subjects receive the instructions for a given part at the beginning of the part.\textsuperscript{14}

In part 1, we elicit subjects risk preferences using the multiple price list format as described above. Each subject is presented with the table of ten decisions on the computer screen and asked to submit his choices via the computer. Only one out of the ten decision is paid. The payoff-relevant row as well as the payoff of the risky lottery is randomly determined at the end of the experiment.

In part 2, subjects compete in 20 repetitions of the contest for a prize of size $R = 200$ points. Efforts are submitted through the computer. To assist subjects in their decision-making, we

\textsuperscript{14}The experimental instructions were originally given in German. An English translation is provided in Appendix E.
provided several tools. First, the instructions contain six fictitious examples. Second, the computer interface offers subjects the opportunity to enter fictitious efforts for themselves and the other investor to learn about the resulting likelihoods of winning and losing the contest and the corresponding number of points at the end of the round. Only two repetitions for the second part are paid, one repetition each from the first and the last ten repetitions. The payoff-relevant repetitions are randomly selected at the end of the experiment.

Finally, repetitions in the third part of the experiment are identical to repetitions in the second part, except that subjects compete for a prize of size $R = 1,000$ points. Only 10 repetitions are conducted in the third part and only one (randomly selected) is paid.

4.3 Procedures

Four sessions were conducted for each treatment. The sessions took place at the experimental laboratory of the Technical University of Munich (“experimenTUM”) in March and November 2015. Students from TU Munich were invited using the ORSEE recruitment system (Greiner, 2015). 22 to 26 subjects participated in each session. The experiment was programmed in zTree (Fischbacher, 2007).

Upon arrival at the lab, subjects were randomly assigned to cubicles that did not allow for any visual communication between them. Subjects were immediately asked to read the computer screen, which contained some basic instructions regarding behaviour in the laboratory and informed subjects about the three parts and that instructions were going to be distributed at the beginning of each part. Once all subjects were seated, paper instructions for part 1 were distributed and subjects were given time to read them at their own pace. Instructions were then read aloud and subjects were permitted to ask questions.

Once all subjects had submitted their ten decisions in the first part, paper instructions for the second part were distributed. Subjects were then read aloud and subjects were given time to read them at their own pace before the instructions were read aloud. Instructions for part 2 were followed by a short quiz to check subjects’ understanding. The experimenters controlled subjects’ answers and explained mistakes in private if necessary. Afterwards, the 20 repetitions of part 2 were run.

Finally, the third part of the experiment was conducted in a similar way as the second one except that only short paper instructions were distributed.

At the end of the experiment, the payoff-relevant decisions were randomly selected by means of a ten-sided dice. Points were converted into cash at the rate 1 point = €0.01 and added to a show-up fee of €4.00. Before collecting their earnings, we asked subjects to fill out a short questionnaire consisting of some demographical questions and some questions related to the experiment. Afterwards, subjects retrieved their earnings in private and left.

Session lasted 100 minutes on average. The average payment was €28.42 in treatment Symmetric, and €27.83 in treatment Asymmetric. Overall, we collected 5,760 effort choices submitted by 192 subjects.

4.4 Hypotheses

To test the theory developed in Section 3, we calculate for each match in which subjects differ in their degree of risk aversion, i.e. the number of safe choices submitted in the first part of the experiment, the winning probability of the venturesome implied by the chosen effort levels and
the induced abilities. We then use these empirical winning probabilities to test the following hypotheses derived from Propositions 1 to 3:

**Hypothesis 1.** Compared to treatment Symmetric, the venturesome’s winning probability in treatment Asymmetric is

(a) higher if he has the high ability,

(b) lower if he has the low ability.

**Hypothesis 2.** The venturesome’s winning probability is

(a) decreasing or inverted U-shaped in his own number of safe choices,

(b) increasing or U-shaped in his opponent’s number of safe choices.

**Hypothesis 3.** The venturesome’s winning probability is larger for the high than for the low prize unless the venturesome has the lower ability and differences in risk aversion are small.

5 Experimental Results

We present our results in four steps: First, we report on risk preferences elicited in the first part of the experiment. Second, we analyse the dynamics of contest decisions across the course of the experiment. Third, we discuss determinants of the probability of winning. Finally, we map those findings to the chosen effort levels.

5.1 Elicited Risk Preferences

![Figure 3](image)

Figure 3 Proportion of safe choices in each decision

Figure 3 plots the proportion of safe choices across the ten decisions separately for each treatment. The left panel contains the choices of all subjects and the right panel restricts to choices of subjects whose decision sequence is consistent with maximisation of expected utility for a strictly increasing utility function. Overall, decisions in the first part of the experiment are inconsistent for 4 subjects (4 percent) in each treatment. Given the low numbers of inconsistent subjects and the fact that risk-aversion cannot be reliably measured with the multiple price list format if subjects are inconsistent, we focus on consistent subjects in our main analyses in Subsections 5.3 and 5.4.
As is evident from comparison to the risk-neutral benchmark (dotted lines), a large majority of subjects is risk-averse in each treatment. The average consistent subject picks the safe amount 5.0 (5.3) times in treatment Symmetric (Asymmetric) and thus significantly more often than the risk neutral prediction ($p < 0.001$ for each treatment). The distribution of safe choices is presented in Table 1. The table also provides parameter intervals subjects would be assigned to under the assumption of CARA- or CRRA-preferences, respectively. The distributions seem very similar across treatments. Indeed, we find that differences between treatments are not significant using a Kolmogorov-Smirnov test ($p > 0.1$). Moreover, our results are very similar to the findings of Holt and Laury (2002) in the low payoff condition.

<table>
<thead>
<tr>
<th>Number of Safe Choices</th>
<th>Range of CARA</th>
<th>Range of CRRA</th>
<th>Consistent All Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2</td>
<td>$\alpha &lt; -0.32$</td>
<td>$r &lt; -0.51$</td>
<td>0.00 0.00 0.00 0.01</td>
</tr>
<tr>
<td>3</td>
<td>$0.32 &lt; \alpha &lt; -0.10$</td>
<td>$-0.51 &lt; r &lt; -0.15$</td>
<td>0.10 0.06 0.10 0.05</td>
</tr>
<tr>
<td>4</td>
<td>$-0.10 &lt; \alpha &lt; 0.10$</td>
<td>$-0.15 &lt; r &lt; 0.13$</td>
<td>0.28 0.26 0.27 0.25</td>
</tr>
<tr>
<td>5</td>
<td>$0.10 &lt; \alpha &lt; 0.31$</td>
<td>$0.13 &lt; r &lt; 0.36$</td>
<td>0.24 0.22 0.26 0.22</td>
</tr>
<tr>
<td>6</td>
<td>$0.31 &lt; \alpha &lt; 0.53$</td>
<td>$0.36 &lt; r &lt; 0.55$</td>
<td>0.24 0.32 0.23 0.32</td>
</tr>
<tr>
<td>7</td>
<td>$0.53 &lt; \alpha &lt; 0.81$</td>
<td>$0.55 &lt; r &lt; 0.72$</td>
<td>0.13 0.12 0.12 0.12</td>
</tr>
<tr>
<td>8 − 9</td>
<td>$0.81 &lt; \alpha$</td>
<td>$0.72 &lt; r$</td>
<td>0.01 0.02 0.01 0.02</td>
</tr>
<tr>
<td>10</td>
<td>n.a.</td>
<td>n.a.</td>
<td>– – 0.01 0.01</td>
</tr>
</tbody>
</table>

Table 1  Distribution of Risk Preferences

5.2 Choice Dynamics

Since we have employed the Nash equilibrium concept as our theoretical benchmark, a valid test of the theory requires that behaviour has stabilised. Figure 4 shows the evolution of average effort levels across repetitions of the game (round henceforth). The left (right) panel contains the results for the second (third) part of the experiment where subjects compete for prize of size $R = 200$ ($R = 1,000$).

Figure 4  Average efforts across rounds

We find a clear downward trend in efforts for subjects competing for the low prize. Averaging across the first (last) five rounds, the average effort equals 71.7 (58.2) in treatment Symmetric,
72.9 (49.3) for subjects of low ability in treatment Asymmetric, and 83.5 (54.7) for subjects of high ability in treatment Asymmetric. Note that the spikes in average efforts in round 11 of treatment Asymmetric coincide with the change in abilities.

In contrast, we find mixed evidence for changes across the third part of the experiment in which subjects compete for the high prize. In particular, efforts in treatment Symmetric and efforts of high ability subjects in treatment Asymmetric hardly change across rounds: The average effort equals 243.3 (256.2) in the first (last) three rounds of treatment Symmetric and 266.6 (261.1) for subjects of high ability in the first (last) three rounds of treatment Asymmetric. On the other hand, the average effort increases from 155.0 in the first three rounds to 230.3 in the last three rounds for subjects of low ability in treatment Asymmetric.

To provide statistical evidence for the reported effects, we estimate panel regression models of the chosen effort levels. The models include as explanatory variables the inverse of the round, dummies for the low and the high ability in treatment Asymmetric, and interactions, and they allow for subject-specific random effects. The results are presented in Table 2. We find clear evidence for a significant decrease of efforts across rounds when subjects compete for the low prize, and a significant increase of efforts for subjects with low ability competing for the high prize in treatment Asymmetric.

Our findings are corroborated by evidence on decision times and the frequency with which subjects made use of the decision-support tool. The corresponding figures and regression results are presented in Appendix D.1. In each case, there is a clear and significant downward trend across rounds, with spikes whenever subjects’ abilities or the prize changed.

Our results lead us to conclude that subjects need time to adapt to the setting. In our main analyses, we therefore focus on late decisions, i.e. decisions made in rounds 11 to 20 (6 to 10) in part 2 (3) of treatment Symmetric and rounds 6 to 10 and 16 to 20 (3 to 5 and 8 to 10) in part 2 (3) of treatment Asymmetric. Exceptions will be mentioned.

<table>
<thead>
<tr>
<th></th>
<th>Low Prize</th>
<th>High Prize</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>SE</td>
</tr>
<tr>
<td>Constant</td>
<td>60.135***</td>
<td>(4.367)</td>
</tr>
<tr>
<td>Asymmetric: Low Ability</td>
<td>-6.250</td>
<td>(6.902)</td>
</tr>
<tr>
<td>Asymmetric: High Ability</td>
<td>-3.846</td>
<td>(5.784)</td>
</tr>
<tr>
<td>Round Trend (= 1/Round)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symmetric</td>
<td>19.722**</td>
<td>(9.980)</td>
</tr>
<tr>
<td>Asymmetric: Low Ability</td>
<td>29.364***</td>
<td>(10.706)</td>
</tr>
<tr>
<td>Asymmetric: High Ability</td>
<td>54.953***</td>
<td>(7.281)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,840</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.017</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Robust standard errors in parentheses, clustered at the session level. Significance level: *** (1%), ** (5%), * (10%).

Table 2  Panel regression results for changes of efforts across rounds.
5.3 Determinants of the Probability of Winning

We focus on constellations where contestants differ in their degree of risk aversion and we analyse the winning probability of the *venturesome* (i.e. the less risk averse contestant).\(^{15}\) Figure 5 plots this probability against the difference in the number of safe choices of the two contestants, separated according to ability (same, low, or high) and size of the prize. For comparison, we also include cases where the two contestants have the same degree of risk aversion but differ in their ability. We make three observations: First, there is a clear effect of ability. The winning probability of the *venturesome* increases (decreases) as his own (his opponent’s) ability increases. Second, the winning probability of the *venturesome* mostly increases as his advantage in risk aversion becomes stronger. The sole exception is the case where the *venturesome* also has the higher ability and the size of the prize is low. Third, a higher prize improves the chances for the *venturesome*, but the effect is small and fails to compensate the impact of ability.

![Figure 5](image-url) The *venturesome*’s probability of winning.

We formally test our hypotheses by performing OLS regressions where the dependent variable is the *venturesome*’s probability of winning, we include as explanatory variables the own and the opponent’s number of safe choices fully interacted with dummies for the low and the high ability in treatment *Asymmetric* and a dummy for the high prize, and standard errors are cluster-corrected for clustering at the session level. In further specifications we also control for demographics and responses to our final questionnaire.\(^{16}\) The results are presented in Table 3. The results fully confirm Hypothesis 1. Compared to treatment *Symmetric*, the *venturesome*’s winning probability in treatment *Asymmetric* is on average about 21 percentage points lower (24 percentage points higher) if he has the low (high) ability and the prize is low. Differences are slightly larger for the high prize (± 0.26), and highly significant for most combinations of the own and the opponent’s risk preferences. Table D.3 in Appendix D.3 contains the marginal effects of the regression with full set of covariates (3) for the main combinations.

\(^{15}\)See Appendix D.2 for an analysis of the remaining matches in which the two subjects in a match have a comparable degree of risk aversion.

\(^{16}\)Specifically, we control for (i) age, gender, academic major, and mother tongue, and (ii) self-assessments on generosity, ambition, frequency of participation in games of chance and board games, importance of winning the contest, and importance of the final payment in the experiment.
<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Winning Probability of the Venturesome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td>Coef.  SE</td>
</tr>
<tr>
<td>Constant</td>
<td>0.379*** (0.054)</td>
</tr>
<tr>
<td>Low Ability</td>
<td>-0.340** (0.116)</td>
</tr>
<tr>
<td>High Ability</td>
<td>0.240** (0.073)</td>
</tr>
<tr>
<td><strong>High Prize</strong></td>
<td></td>
</tr>
<tr>
<td>× Symmetric</td>
<td>0.152** (0.057)</td>
</tr>
<tr>
<td>× Low Ability</td>
<td>0.027 (0.062)</td>
</tr>
<tr>
<td>× High Ability</td>
<td>0.101* (0.048)</td>
</tr>
<tr>
<td><strong># Safe Choices</strong></td>
<td></td>
</tr>
<tr>
<td>× Symmetric × Low Prize</td>
<td>-0.029 (0.032)</td>
</tr>
<tr>
<td>× Symmetric × High Prize</td>
<td>-0.005 (0.012)</td>
</tr>
<tr>
<td>× Low Ability × Low Prize</td>
<td>-0.058** (0.023)</td>
</tr>
<tr>
<td>× Low Ability × High Prize</td>
<td>-0.005 (0.038)</td>
</tr>
<tr>
<td>× High Ability × Low Prize</td>
<td>0.048** (0.014)</td>
</tr>
<tr>
<td>× High Ability × High Prize</td>
<td>0.013 (0.014)</td>
</tr>
<tr>
<td><strong># Safe Choices Opponent</strong></td>
<td></td>
</tr>
<tr>
<td>× Symmetric × Low Prize</td>
<td>0.067* (0.028)</td>
</tr>
<tr>
<td>× Symmetric × High Prize</td>
<td>0.024 (0.021)</td>
</tr>
<tr>
<td>× Low Ability × Low Prize</td>
<td>0.110** (0.043)</td>
</tr>
<tr>
<td>× Low Ability × High Prize</td>
<td>0.099** (0.031)</td>
</tr>
<tr>
<td>× High Ability × Low Prize</td>
<td>0.041 (0.024)</td>
</tr>
<tr>
<td>× High Ability × High Prize</td>
<td>0.038 (0.028)</td>
</tr>
<tr>
<td><strong>Demographics Venturesome</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.028 (0.027)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001 (0.003)</td>
</tr>
<tr>
<td># Siblings</td>
<td>-0.003 (0.008)</td>
</tr>
<tr>
<td>Non-BA Student</td>
<td>-0.031 (0.030)</td>
</tr>
<tr>
<td>Non-German</td>
<td>0.028 (0.028)</td>
</tr>
<tr>
<td><strong>Demographics Opponent</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.009 (0.035)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.005 (0.003)</td>
</tr>
<tr>
<td># Siblings</td>
<td>0.005 (0.009)</td>
</tr>
<tr>
<td>Non-BA Student</td>
<td>0.011 (0.039)</td>
</tr>
<tr>
<td>Non-German</td>
<td>0.006 (0.028)</td>
</tr>
<tr>
<td><strong>Questionnaire Responses Venturesome</strong></td>
<td></td>
</tr>
<tr>
<td>Participation Lotteries</td>
<td>-0.007 (0.004)</td>
</tr>
<tr>
<td>Participation Games</td>
<td>0.026*** (0.005)</td>
</tr>
<tr>
<td>Ambition</td>
<td>0.026* (0.010)</td>
</tr>
<tr>
<td>Generosity</td>
<td>0.004 (0.004)</td>
</tr>
<tr>
<td>Importance Winning</td>
<td>0.027** (0.009)</td>
</tr>
<tr>
<td>Importance Payment</td>
<td>-0.011* (0.006)</td>
</tr>
<tr>
<td><strong>Questionnaire Responses Opponent</strong></td>
<td></td>
</tr>
<tr>
<td>Participation Lotteries</td>
<td>-0.020 (0.013)</td>
</tr>
<tr>
<td>Participation Games</td>
<td>-0.002 (0.006)</td>
</tr>
<tr>
<td>Ambition</td>
<td>0.019* (0.009)</td>
</tr>
<tr>
<td>Generosity</td>
<td>0.004 (0.009)</td>
</tr>
<tr>
<td>Importance Winning</td>
<td>-0.039** (0.012)</td>
</tr>
<tr>
<td>Importance Payment</td>
<td>0.004 (0.009)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,243</td>
</tr>
<tr>
<td>R²</td>
<td>0.360</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses, clustered at the session level. Significance level: *** (1%), ** (5%), * (10%).

Table 3 Determinants of the venturesome’s probability of winning.
Second, the **venturesome**’s winning probability is decreasing in his own degree of risk aversion if he has the same or a lower ability than his opponent. The coefficient on the own number of safe choices is always negative in these cases, though we obtain significance only if ability and prize are low. In contrast, the winning probability increases in the **venturesome**’s degree of risk aversion if he also has a higher ability as the coefficient is positive regardless of the size of the prize (again, significance only obtains with a low prize). These results confirm part (a) of our second hypothesis. Indeed, as predicted, the winning probability is increasing in the own degree of risk aversion if the venturesome is likely to have a relatively high probability of winning since he also has the higher ability.

Third, we find a positive impact of the opponent’s degree of risk aversion on the **venturesome**’s winning probability as predicted in Hypothesis 2(b). This obtains across treatments and abilities, and for both a low and a high prize, but the increase is significant only if the contest is symmetric and the prize is low, or if the venturesome has the lower ability. Contrary to the results for the own degree of risk aversion, we do not find a non-monotonic relationship between the probability of winning and the opponent’s risk aversion. However, since this would require the winning probability to be relatively low, the most favourable case is a less able but more risk averse contestant and thus not included in our regression sample.

Fourth, we note that the impact of both types of risk aversion is smaller if the prize is high which suggests that the (own or opponent’s) risk aversion is less important in this case.

To obtain evidence for our third hypothesis, we regress the **venturesome**’s probability of winning on dummies for the difference between the number of safe choices of the two contestants fully interacted with dummies for the low and the high ability in treatment *Asymmetric* and a dummy for the high prize. We also control for the **venturesome**’s number of safe choices, demographics, and responses to our final questionnaire, and we cluster-correct standard errors for clustering at the session level. Table 4 reports the marginal effects of moving from the low to the high prize on the **venturesome**’s probability of winning by ability and difference in risk aversion (regression results are presented in Table D.4 in Appendix D.3).

<table>
<thead>
<tr>
<th>Δ(S)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symmetric</strong></td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.082**</td>
<td>0.097***</td>
<td>0.026</td>
<td>-0.035</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.027)</td>
<td>(0.040)</td>
<td>(0.134)</td>
</tr>
<tr>
<td><strong>Asymmetric: Low Ability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.036</td>
<td>0.021</td>
<td>0.026</td>
<td>-0.044</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.028)</td>
<td>(0.034)</td>
<td>(0.043)</td>
</tr>
<tr>
<td><strong>Asymmetric: High Ability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.072**</td>
<td>0.100*</td>
<td>0.072***</td>
<td>0.129**</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.051)</td>
<td>(0.018)</td>
<td>(0.065)</td>
</tr>
</tbody>
</table>

*Note: Δ(S) = # Safe Choices Opponent - # Safe Choices*

Robust standard errors in parentheses, obtained using the Delta method.
Significance level: *** (1%), ** (5%), * (10%).

**Table 4** Marginal effects of switching from the low to the high prize on the **venturesome**’s probability of winning.

The results partially confirm Hypothesis 3. Competing for a high instead of a low prize always increases the **venturesome**’s winning probability (i) if he has the higher ability, and (ii) if abilities are symmetric and the difference in risk aversion is not too large. The **venturesome**’s probability of winning is also higher for the high than for the low prize if he has the lower ability,
but the differences are not significant and considerably smaller than in the two other cases and
the average probability of the venturesome remains far below one-half. Our results do however
suggest that lower risk aversion can compensate lower ability to some degree: The coefficients
of the dummies for the difference in risk aversion exhibit an increasing pattern especially if the
ability of the venturesome is low. Indeed, treating the difference as a continuous variable yields
a significantly positive coefficient in this case both for the low and the high prize (see Table D.5
in Appendix D.3).

Finally, though we do not find any influence of demographics, some of our questionnaire
items impact the venturesome’s winning probability. For example, this probability is higher if
the venturesome takes part in board games more often, has a higher ambition, and assigns a
higher importance to winning, and it is lower if he considers the final payment less important.

5.4 Determinants of Effort Choices

Table 5 gives an overview of average effort levels and corresponding standard deviations across
late rounds and matches of consistent subjects. In line with many other experimental studies on
contest behaviour (Sheremeta, 2013, Dechenaux et al., 2015), we find significant heterogeneity
of individual efforts and significant overbidding relative to the equilibrium predictions, which
is more pronounced for the low than for the high prize. Moreover, we find an asymmetric
discouragement effect in the sense that subjects bid less in treatment Asymmetric than in
treatment Symmetric, if they have the low ability, but not if they have the high ability. March
and Sahm (2017) provide a thorough discussion of these findings.

<table>
<thead>
<tr>
<th>Treatment/participant Type</th>
<th>Low Prize: $R = 200$</th>
<th>High Prize: $R = 1,000$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symmetric</td>
<td>57.8 (40.2)</td>
<td>255.1 (148.0)</td>
</tr>
<tr>
<td>Asymmetric: Low Ability</td>
<td>50.8 (62.2)</td>
<td>193.3 (209.7)</td>
</tr>
<tr>
<td>Asymmetric: High Ability</td>
<td>56.0 (30.5)</td>
<td>266.7 (138.7)</td>
</tr>
</tbody>
</table>

Theoretical predictions in brackets, standard deviations in parentheses

Table 5 Average effort levels

To map our findings on the venturesome’s probability of winning on effort levels, we estimate
panel regression models of the relative effort levels, i.e. effort divided by the size of the prize.
The models include as explanatory variables the own and the opponent’s number of safe choices
fully interacted with dummies for the low and the high ability in treatment Asymmetric and
a dummy for the high prize, and they allow for subject-specific random effects. In further
specifications, we also incorporate demographics and responses to our final questionnaire. The
estimation results for all subjects and separately for the more and the less risk averse subject
in each pair are presented in Appendix D.4.

The estimation confirms, first, that subjects invest less effort than in the symmetric contest
when facing a more able contestant. For the more risk averse, the reduction is the larger the
higher the own and the opponents’ degree of risk aversion. For the venturesome, the opposite
holds and effects are mainly present for the high prize. In contrast, subjects barely respond
to an increase in their own ability. Accordingly, the increase in the venturesome’s winning
probability due to an increase of his ability is not driven by an increase in his (relative) effort.

We are grateful to Rudi Stracke for suggesting this interpretation.
Second, the \textit{venturesome}'s effort does not change significantly with the own and the opponent's degree of risk aversion except if he also has the higher ability. In this case, he invests the less the more risk averse his opponent is. In contrast, the more risk averse subject's effort is decreasing in his own degree of risk aversion, and the decrease is larger in an asymmetric contest. The more risk averse subject also responds to an increase in his opponent's degree of risk aversion if and only if the prize is high. However, whereas in a symmetric contest he invests the more the more risk averse his opponent is, the opposite holds true in an asymmetric contest. The results suggest that the positive relationship between the \textit{venturesome}'s winning probability and his own degree of risk aversion if he has the high ability is mainly driven by the effort reduction of his opponent.

Third, we find that an increase of the prize leads to a (significant) reduction of relative efforts unless the contest is asymmetric and a subject has the high ability. In particular, in situations where the \textit{venturesome} has the lower ability, neither the \textit{venturesome} nor the gifted spends significantly less effort if the price is high. Thus, increasing the prize does not improve the chances of the \textit{venturesome} in these situations.

Finally, we find that subjects who have more experience with board games or assign a higher importance to winning the contest invest more.

6 Applications

The results of this paper apply to many contest-like situations in various areas of everyday life. In this section, we discuss a non-exhaustive series of examples.

6.1 Personnel and labour economics

The human resource management uses contests for various purposes like recruitment, promotion, and compensation of workers. Over the last few years, two topics have received particular interest in the public debate about labour market policies: the gender gap and the compensation of executives.

\textit{The gender gap}

In the labour market of most countries, gender differences persist and become manifest in a participation gap, a remuneration gap, and an advancement gap (World Economic Forum, 2013). The socio-scientific literature offers various explanations emphasising the role of both, genuine differences between women and men (see e.g. Paglin and Rufolo, 1990) as well as institutional discrimination against women (see e.g. Albrecht et al., 2003, Arulampalam et al., 2007). Yet the interplay between gender specific traits and institutions governing labour market decisions has not been fully explored. In particular, the fact that many decisions on employment, compensation, and promotion are based on contests has been largely neglected. Taking this institutional feature into account, our analysis offers a novel explanation for the gender gap.

Empirical and experimental studies comparing the characteristics of women and men support the following stylised facts: While there are no significant differences with respect to intellectual abilities (American Psychological Association, 2014), on average, she is significantly more risk averse (Byrnes et al., 1999, Croson and Gneezy, 2009, Noussair et al., 2014).
Accordingly, a promotion contest between the average woman and the average man exhibits predominance of heterogeneity in risk aversion. Proposition 3(b) then predicts similar winning probabilities for moderate compensation levels. For big salary gaps, however, the predicted Nash winner is male. Hence, the model explains both aspects of the gender gap: First, on average, more men than women are employed/promoted. Second, on average, promoted women earn less than promoted men.\textsuperscript{18}

Executive compensation

Given the perception that the financial crisis of 2007-2008 might – at least partly – originate from excessive risk-taking by top managers, should the government regulate (e.g. limit) executive compensation?\textsuperscript{19} Suppose that the promotion of top managers is governed by predominance of differences in risk aversion. If some firm does not fully internalise the risk that the decisions of its executives impose on the society as a whole (e.g. due to limited liability), it might offer promotion premiums that are too high, thereby promoting managers that are too venturesome, in the sense that regulations (limitations) may increase executive risk aversion and, hence, total welfare.

Relative performance pay

Relative performance pay is a contest-like compensation scheme which is both, widely used in practice and extensively discussed in the literature originating from the seminal paper of Lazear and Rosen (1981). Though there certainly is self-selection along both dimensions, the majority of people seem to base their occupational choice rather on abilities than on risk considerations.\textsuperscript{20} For (mature) businesses, where this argument is valid, predominance of heterogeneity in risk aversion seems a plausible assumption. Proposition 3(b) then predicts that payments based on relative performance should be higher in industries in which risk aversion is an obstacle rather than a virtue. Comparing, for instance, the financial industry and the aircraft industry supplies some anecdotal evidence for this testable hypothesis.

6.2 Political economy

The model offers similar implications for the selection of politicians in the political process. For example, an election may be interpreted as a contest between agents competing for the rent from holding office. Given the assumption that in many (mature) democracies there is predominance of heterogeneity in risk aversion among candidates, moderate compensation for office-holders may increase the probability that the more able candidate will be elected (c.f. Proposition

\textsuperscript{18}The predictions of the model are also in line with two more sophisticated empirical observations: First, most part of the gender wage gap vanishes if one controls for the type of occupation (Bertrand and Hallock, 2001). This observation shows that wages are not gender-specific per se but occupation-specific. Indeed, the model then predicts a lower fraction of women in highly paid jobs but no gender wage gap within a certain type of occupation. Second, gender differences in risk preferences disappear if one controls for the type of occupation (Croson and Gneezy, 2009, Section 2.3). In fact, conditional on being promoted into an occupation of a certain wage-type, the model predicts that the risk-preferences of men and women should not differ, because selection does not rest upon gender directly but upon risk-aversion.

\textsuperscript{19}See e.g. Bebchuk and Spamann (2010).

\textsuperscript{20}For example, Paglin and Rufolo (1990) show that comparative advantages are an important determinant of the individual choice of occupation.
Moreover, assuming that the less risk averse candidate also chooses the riskier policies, the results entail the following hypothesis: Higher rents from office lead to riskier policies. Hence, there might be a case for the limitation of monetary incentives for politicians similar to that of executives.

6.3 Sports economics

For many mature sports, the assumption that athletes differ by less in abilities than in attitudes towards risk appears reasonable. Given this, the model may explain event-dependent differences in the prize money: It is optimal for organisers to offer a lower prize money for events that aim at the selection of talent, for example qualifying races like the Olympic Trials, than for events, like the Golden League Meetings, that aim at a balanced competition because closeness exerts a positive externality on other markets ($R_0 < R_1$, c.f. Proposition 3(b)). Similarly, the analysis gives rise to the following hypothesis: the higher the prize money of an event, the less risk averse the winners on average.

6.4 Law and economics

The considered contest may be understood as a model of litigation\textsuperscript{21} reinterpreting the rent $R$ as the amount in dispute and the ratio $\frac{\theta_1}{\theta_2}$ as a pre-trial head start, the so-called objective merits of the case (Hughes and Woglom, 1996). As the model shows, for close cases, i.e. for $\frac{\theta_1}{\theta_2}$ close to 1, the winning probability is very sensitive to the litigants’ risk preferences as well as to the amount in dispute. This gives rise to the following hypothesis: Close cases are more often won by the less risk averse litigant than cases with an odds-on favourite. Moreover, even in clear cases, the favourite may have an arbitrarily small winning probability if he is risk averse and encounters an (almost) risk neutral litigant in a case in which the amount in dispute is sufficiently high (c.f. Proposition 3(b)). For example, think of litigation between a risk averse individual and a risk neutral firm or institution. This constitutes some rationale for legal insurance.

7 Concluding Remarks

In this paper, we have analysed how individual risk preferences affect the likelihood of selecting the more able contestant within a two-player Tullock contest. Our theoretical analysis and our numerical simulations have established two main predictions: First, an increase in the risk aversion of a player worsens her odds unless she already has a sufficiently large advantage. Second, if the prize money is sufficiently large, a less able but less risk averse contestant can achieve an equal or even higher probability of winning than a more able but more risk averse opponent. Moreover, we have conducted a laboratory experiment providing empirical evidence for both, the non-monotonic impact and the compensating effect of risk aversion on winning probabilities.

Our insights provide positive explanations for phenomena like the gender gap and offer suggestions for normative contest design. For example, if the contest aims at selecting the

\textsuperscript{21}Since investments into the contest are sunk, the model represents the so-called American rule under which litigants are responsible for paying their own legal expenses, regardless of the outcome of the dispute.
most able but exhibits predominance of heterogeneity in risk aversion, then the limitation of (monetary) incentives in business (wage differentials), politics (rents from office), and sports (price money) may be optimal.

Acknowledgements

We thank Richard Cornes, Christian Feilcke, Hans Hvide, Kai Konrad, Wolfgang Leininger, Thomas Nehfischer, Marco Runkel, Rudi Stracke, and seminar audiences at Düsseldorf Institute for Competition Economics, University of Bamberg, University of Konstanz, University of Munich, Technical University of Munich, Universität der Bundeswehr München, Erasmus University Rotterdam, and Uppsala University.
Appendix

Appendix A provides closed-form solutions of individual efforts and the competitive balance in equilibrium with CARA-preferences. Appendix B contains the proofs of the theoretical results. Appendix C presents numerical results for the equilibrium with CRRA-preferences. Appendix D complements the statistical analysis reported in the main text. Finally, Appendix E contains an English translation of the experimental instructions.

A Explicit Solutions for CARA-Preferences

If participants have CARA-preferences, the equilibrium values of competitive balance and individual efforts can be computed explicitly. The closed-form solutions provided below may be useful in creating numerical examples and simulations.

A.1 Competitive Balance

Equation (7) can be transformed into a quadratic equation for the competitive balance in equilibrium; as \( \frac{\theta_1 \delta_2}{\theta_2 \delta_1} > 0 \), only the positive root yields a feasible solution \( q > 0 \), i.e.

\[
q = \sqrt{\frac{\theta_2 \delta_1}{\theta_1 \delta_2} + \left( \frac{\theta_1 \beta_2 - \theta_2 \beta_1}{2 \theta_1 \delta_2} \right)^2 - \frac{\theta_1 \beta_2 - \theta_2 \beta_1}{2 \theta_1 \delta_2}}.
\] (A.1)

A.2 Effort

With CARA-preferences, we use (3), (4), and (5) to rewrite the FOCs (2) as follows:

\[
\frac{\theta_1 \theta_2 x_2}{\theta_1 x_1 + \theta_2 x_2} = \delta_1 \theta_1 x_1 + \beta_1 \theta_2 x_2,
\] (A.2)

\[
\frac{\theta_1 \theta_2 x_1}{\theta_1 x_1 + \theta_2 x_2} = \delta_2 \theta_2 x_2 + \beta_2 \theta_1 x_1.
\] (A.3)

After division by \( x_2 \) and \( x_1 \), respectively, the left hand sides of the two FOCs coincide, and so do the right hand sides, i.e.

\[
\delta_1 \theta_1 \frac{x_1}{x_2} + \beta_1 \theta_2 = \delta_2 \theta_2 \frac{x_2}{x_1} + \beta_2 \theta_1.
\]

The resulting quadratic equation has only one positive root \( x_1 = \gamma x_2 \) with

\[
\gamma := \frac{\sqrt{4 \theta_1 \delta_1 \theta_2 \delta_2 + (\theta_2 \beta_1 - \theta_1 \beta_2)^2} - (\theta_2 \beta_1 - \theta_1 \beta_2)}{2 \theta_1 \delta_1}.
\]

Substituting \( x_1 \) in equation (A.2) yields

\[
\frac{\theta_1 \theta_2}{\theta_1 \gamma + \theta_2} = (\delta_1 \theta_1 \gamma + \beta_1 \theta_2) x_2.
\]
Inserting $\gamma$ and rearranging terms, participant $i$’s equilibrium effort reads as follows:

$$x_i = \frac{2\theta_i\theta_j\delta_j}{\theta_i^2\beta_j\delta_j + \theta_j^2\beta_i^2 + \theta_i\theta_j(2\delta_i\delta_j - \beta_i\beta_j + \beta_i\delta_j) + (\theta_i\delta_j + \theta_j\beta_i)\sqrt{4\theta_j\delta_j\delta_i + (\theta_i\beta_j - \theta_j\beta_i)^2}}.$$  \hspace{0.5cm} \mbox{(A.4)}

\section*{B \ Proofs}

\subsection*{B.1 \ Proof of Proposition 1.}

Proposition 1 follows immediately from the following

\textbf{Lemma 1.} $\Phi$ is strictly increasing in $q$: $\frac{\partial \Phi}{\partial q} > 0$.

\textit{Proof.} Differentiate $\Phi$ with respect to $q$, use the shortcuts $\beta_i := \beta(\alpha_i)$ as well as $\delta_i := \delta(\alpha_i)$, and remember that $\delta_i = \beta_i - \alpha_i$ for $i \in \{1, 2\}$:

$$\frac{\partial \Phi}{\partial q} = \frac{(1 + q)\beta_2 - q\alpha_2}{(1 + q)\beta_1 - \alpha_1} + q \cdot \frac{(\beta_2 - \alpha_2)(1 + q)\beta_1 - \alpha_1 - [(1 + q)\beta_2 - q\alpha_2]\beta_1}{(1 + q)\beta_1 - \alpha_1}$$

$$= \frac{[(1 + q)\beta_2 - q\alpha_2] \cdot [(1 + q)\beta_1 - \alpha_1] + q \cdot (\alpha_1\alpha_2 - \alpha_1\beta_2 - \alpha_2\beta_1)}{[(1 + q)\beta_1 - \alpha_1]^2}$$

$$= \frac{\beta_2(\beta_1 - \alpha_1) + q^2\beta_1(\beta_2 - \alpha_2) + 2q(\beta_1 - \alpha_1)(\beta_2 - \alpha_2)}{[(1 + q)\beta_1 - \alpha_1]^2}$$

$$= \frac{\beta_2\delta_1 + q^2\beta_1\delta_2 + 2q\delta_1\delta_2}{[(1 + q)\beta_1 - \alpha_1]^2} > 0.$$  \hspace{0.5cm} \mbox{(B.1)}

\subsection*{B.2 \ Proof of Proposition 2.}

First note that Proposition 2 is equivalent to the following statement: The competitive balance $q$ is ceteris paribus

(a) either increasing or U-shaped in $\alpha_1$,

(b) either decreasing or inverted U-shaped in $\alpha_2$.

The proof rests upon the following two lemmas.

\textbf{Lemma 2.} The equilibrium competitive balance has the following slope

(a) with respect to $\alpha_1$:

$$\frac{\partial q}{\partial \alpha_1} \begin{cases} < 0 \text{ if } q < q_1(\alpha_1), \\ = 0 \text{ if } q = q_1(\alpha_1), \\ > 0 \text{ if } q > q_1(\alpha_1), \end{cases}$$  \hspace{0.5cm} \mbox{(B.1)}

where $q_1(\alpha_1) := \frac{\delta(\alpha_1)/\partial \alpha_1}{\delta(\alpha_1)/\partial \alpha_1}$.
\[(b) \text{ with respect to } \alpha_2:\]
\[\frac{\partial q}{\partial \alpha_2} \left\{ \begin{array}{ll}
< 0 & \text{if } q < q_2(\alpha_2), \\
= 0 & \text{if } q = q_2(\alpha_2), \\
> 0 & \text{if } q > q_2(\alpha_2),
\end{array} \right. \tag{B.2}
\]

where \(q_2(\alpha_2) := -\frac{\partial \beta(\alpha_2)/\partial \alpha_2}{\partial \Phi/\partial \alpha_2}\).

**Proof.** We focus on the proof of part (a). The proof of part (b) is completely analogous and therefore omitted. We use the shortcuts \(\beta_i := \beta(\alpha_i), \delta_i := \delta(\alpha_i), \text{ and } \phi_i := \phi_i(q, \alpha_i, R),\) where
\[
\begin{align*}
\phi_1(q, \alpha_1, R) & := (1 + q)\beta(\alpha_1) - \alpha_1, \\
\phi_2(q, \alpha_2, R) & := (1 + q)\beta(\alpha_2) - q\alpha_2.
\end{align*}
\]

The implicit function theorem yields \(dq/d\alpha_1 = -\Phi/\partial \alpha_1\), where \(\partial \Phi/\partial q > 0\) by Lemma 1 and \(\partial \Phi/\partial \alpha_1 = q\frac{\partial \phi_1/ \partial \alpha_1}{\partial \phi_1/\partial q}\) as \(\Phi = q\phi_1\). Note that \(\phi_i > 0\) since \(\beta_i > \alpha_i\). Hence, \(\text{sign}(dq/d\alpha_1) = \text{sign}(\partial \Phi/\partial \alpha_1) = \text{sign}(\partial \phi_1/\partial \alpha_1)\). Now differentiate \(\phi_1 = (1 + q)\beta(\alpha_1) - \alpha_1 = \delta_1 + q\beta_1\) with respect to \(\alpha_1:\)
\[
\frac{\partial \phi_1}{\partial \alpha_1} = \frac{\partial \delta_1}{\partial \alpha_1} + q \cdot \frac{\partial \beta_1}{\partial \alpha_1}. \tag{B.3}
\]
Equation (B.3) immediately implies the properties asserted in (B.1). \(\square\)

Equation (B.3) sheds light on the two opposing effects of a marginal increase of participant 1’s degree of risk aversion: The self-protection effect is captured by the term \(\partial \delta_1/\partial \alpha_1 < 0\) whereas the gambling effect is captured by the term \(\partial \beta_1/\partial \alpha_1 > 0\). The relative strength of these two effects is scaled by the actual competitive balance \(q\). Lemma 2 applies only locally since the cutoff values \(q_i(\alpha_i)\) themselves depend on \(\alpha_i\). In order to attain a global picture, the following Lemma explores this dependency.

**Lemma 3.** For all \(\alpha_i > 0\)

\[(a) \frac{\partial q_1(\alpha_1)}{\partial \alpha_1} < 0, \lim_{\alpha_1 \to 0} q_1(\alpha_1) = 1, \lim_{\alpha_1 \to \infty} q_1(\alpha_1) = 0, \lim_{\alpha_1 \to \infty} q = \infty.
\]

\[(b) \frac{\partial q_2(\alpha_2)}{\partial \alpha_2} > 0, \lim_{\alpha_2 \to 0} q_2(\alpha_2) = 1, \lim_{\alpha_2 \to \infty} q_2(\alpha_2) = \infty, \lim_{\alpha_2 \to \infty} q = 0.
\]

**Proof.** We focus on the proof of part (a). The proof of part (b) is completely analogous and therefore omitted. Again, we use the shortcuts \(\beta_i := \beta(\alpha_i)\) and \(\delta_i := \delta(\alpha_i)\).

First, we show that \(q_1(\alpha_1) := \frac{\delta(\alpha_1)}{\beta(\alpha_1)}\) is decreasing in \(\alpha_1\), where \(\delta(\alpha_1) := \partial \delta_1/\partial \alpha_1\) and \(\beta(\alpha_1) := \partial \beta_1/\partial \alpha_1\). Remember that \(\delta(\alpha) = \beta(\alpha) - \alpha\) Hence, \(\delta(\alpha) = \beta(\alpha) - \alpha\) and
\[
q_1(\alpha_1) = -\frac{\delta(\alpha_1)}{\beta(\alpha_1)} = \frac{1 - \beta(\alpha_1)}{\beta(\alpha_1)} = \frac{1}{\beta(\alpha_1)} - 1.
\]
Differentiating \(q_1(\alpha_1)\) with respect to \(\alpha_1\) yields \(q_1'(\alpha_1) = -\frac{\delta(\alpha_1)}{\beta(\alpha_1)^2}\). Accordingly, in order to prove that \(q_1(\alpha_1)\) is decreasing in \(\alpha_1\), it suffices to show that \(\beta'(\alpha) > 0\). Compute
\[
\beta'(\alpha) = \frac{\partial \beta(\alpha)}{\partial \alpha} = \frac{1 - (1 + \alpha R)e^{-aR}}{(1 - e^{-aR})^2} > 0 \tag{B.4}
\]

and
\[
\beta''(\alpha) = \frac{\partial^2 \beta(\alpha)}{\partial \alpha^2} = \frac{Re^{-\alpha R}}{(1 - e^{-\alpha R})^3} \cdot [\alpha R - 2 + (\alpha R + 2)e^{-\alpha R}].
\]
However, this expression is positive since \(\alpha R + 2 > (2 - \alpha R)e^{\alpha R}\) which can be easily verified using the identity \(e^X = \sum_{k=0}^{\infty} \frac{X^k}{k!}\) for any real \(X\).

Now consider the limits of \(q_1(\alpha)\) for \(\alpha_1 \to 0\) and \(\alpha_1 \to \infty\). Observe from (B.4) that \(\lim_{\alpha_1 \to \infty} \beta'(\alpha) = 1\) and, hence, \(\lim_{\alpha_1 \to \infty} q_1(\alpha_1) = 0\). Moreover, applying l'Hospital’s rule twice, compute from (B.4) that
\[
\lim_{\alpha \to 0} \beta'(\alpha) = \lim_{\alpha \to 0} \frac{-[Re^{-\alpha R} - (1 + \alpha R)Re^{-\alpha R}]}{2(1 - e^{-\alpha R})Re^{-\alpha R}} = \lim_{\alpha \to 0} \frac{\alpha R}{2(1 - e^{-\alpha R})} = \lim_{\alpha \to 0} \frac{R}{2Re^{-\alpha R}} = \frac{1}{2}
\]
and, hence, \(\lim_{\alpha_1 \to 0} q_1(\alpha_1) = 1\).

Finally, consider the limit of \(q\) for \(\alpha_i \to \infty\). Since \(\beta'(\alpha) = \frac{\alpha}{1 - e^{-\alpha R}} \to \infty\) for \(\alpha \to \infty\) and
\[
\lim_{\alpha \to \infty} \delta(\alpha) = \lim_{\alpha \to \infty} \frac{\alpha e^{-\alpha R}}{1 - e^{-\alpha R}} = \lim_{\alpha \to \infty} \frac{\alpha}{e^{\alpha R} - 1} = \lim_{\alpha \to \infty} \frac{1}{Re^{\alpha R}} = 0
\]
by l’Hospital’s rule, equation (A.1) implies that \(q \to \infty\) for \(\alpha_1 \to \infty\).

Applying these results and Lemma 2, two cases may arise: If \(\lim_{\alpha_1 \to 0} q \geq 1\) then \(q\) will be strictly increasing in \(\alpha_1\). If instead \(\lim_{\alpha_1 \to 0} q < 1\) then there will exist a unique \(\alpha_1^{\text{max}} > 0\) for which \(q = q_1(\alpha_1^{\text{max}})\). In this case, \(q\) is decreasing for all \(\alpha_1 < \alpha_1^{\text{max}}\) and increasing for all \(\alpha_1 > \alpha_1^{\text{max}}\). Put differently, \(\alpha_1^{\text{max}}\) is the level of risk aversion that, ceteris paribus, maximises participant 1’s winning probability. Analog reasoning holds for the comparative statics with respect to \(\alpha_2\). This completes the proof of Proposition 2.

\(\Box\)

## B.3 Proof of Proposition 3.

The proof of Proposition 3 is based on two propaedeutic lemmas. We start with an observation for contests with very small rents. In this case, the perceived riskiness of the contest is low and, therefore, risk considerations play a negligible role. For the most part, the participants’ winning probabilities are determined by the ability ratio because their investments tend to coincide. More formally, \(\lim_{R \to 0} \xi = 1\) for the participants’ relative effort in equilibrium, and hence:

**Lemma 4.** \(\lim_{R \to 0} q = \frac{\theta_2}{\theta_1}\) for all \(\theta_1, \theta_2 > 0\) and \(\alpha_1, \alpha_2 > 0\).
Proof. Starting from equation (8) and applying l'Hospital’s rule twice, compute
\[
\lim_{R \to 0} \Phi = \lim_{R \to 0} q \cdot \frac{(1 + q)\beta(\alpha_2) - q\alpha_2}{(1 + q)\beta(\alpha_1) - \alpha_1} = \frac{\partial \beta(\alpha_2)}{\partial \alpha_2} \left(1 - e^{-\alpha_1 R}\right)^2 \left(1 - e^{-\alpha_2 R}\right)^2
\]
\[
= q \cdot \frac{\alpha_2^2}{\alpha_1^2} \cdot \left(\lim_{R \to 0} \frac{1 - e^{-\alpha_1 R}}{1 - e^{-\alpha_2 R}}\right)^2
\]
\[
= q \cdot \frac{\alpha_2^2}{\alpha_1^2} \cdot \left(\lim_{R \to 0} \frac{\alpha_1 e^{-\alpha_1 R}}{\alpha_2 e^{-\alpha_2 R}}\right)^2 = q.
\]

Note that if players are risk neutral they will exert the same effort yielding \( q = \frac{\alpha_2}{\alpha_1} \) for all \( R > 0 \) (Baik, 1994). In this sense, for very small rents, contestants behave as if they were risk neutral.

Next, we derive a general condition which is both necessary and sufficient for participant 1 to be the Nash winner, i.e. the participant with the higher winning probability in equilibrium.

Lemma 5. In the equilibrium of the contest, \( p_1 \geq p_2 \) if and only if
\[
\frac{\theta_1}{\theta_2} \geq \frac{\phi(\alpha_1)}{\phi(\alpha_2)}, \tag{B.5}
\]
where \( \phi(\alpha) := 2\beta(\alpha) - \alpha \) for all \( \alpha, R > 0 \) has the following properties:
(a) \( \phi(\alpha) > \alpha \),
(b) \( \phi'(\alpha) := \frac{\partial \phi(\alpha)}{\partial \alpha} > 0 \),
(c) \( \frac{\partial \phi(\alpha)}{\partial R} < 0 \),
(d) \( \frac{\partial \phi(\alpha)}{\partial R} > 0 \).

The contest is even if and only if (B.5) holds with equality.

Proof. Since \( \frac{\partial \theta_2}{\partial \theta_1} > 0 \) by Lemma 1, equation (8) implies that \( q \leq 1 \) if and only if
\[
\frac{\theta_2}{\theta_1} \leq \frac{2\beta(\alpha_2) - \alpha_2}{2\beta(\alpha_1) - \alpha_1} = \frac{\phi(\alpha_2)}{\phi(\alpha_1)},
\]
which is obviously equivalent to inequality (B.5). Note that the condition is met with equality if and only if \( q = 1 \). We now show the asserted properties of \( \phi \).
(a) \( \phi(\alpha) = 2\beta(\alpha) - \alpha = \alpha \cdot \frac{e^{\alpha R} - 1}{e^{\alpha R} - 1} > \alpha \).
(b) Use this expression and compute
\[
\phi'(\alpha) = \frac{e^{2\alpha R} - (1 + 2\alpha Re^{\alpha R})}{(e^{\alpha R} - 1)^2},
\]
33
which is positive since $e^{2\alpha R} > 1 + 2\alpha Re^{\alpha R}$. The last inequality can be easily verified using the identity $e^X = \sum_{k=0}^{\infty} \frac{X^k}{k!}$ for any real $X$.

(c) $\frac{\partial \phi(\alpha)}{\partial R} = -\frac{2\alpha^2 e^{\alpha R}}{(e^{\alpha R} - 1)^2} < 0$.

(d) Use this expression and compute

$$\frac{\partial \phi' (\alpha)}{\partial R} = -\frac{2\alpha e^{\alpha R}}{(e^{\alpha R} - 1)^3} \cdot [(2 - R\alpha)e^{\alpha R} - 2 - R\alpha],$$

which is positive since the term in brackets is negative. Again, the last statement can be easily verified using the identity $e^X = \sum_{k=0}^{\infty} \frac{X^k}{k!}$ for any real $X$.

We now apply the two lemmas in order to prove Proposition 3.

**Part (a):** With $\lim_{R \to 0} q = \frac{\alpha}{\beta} < 1$ by Lemma 4, statement (i) follows immediately from statement (ii). It remains to show that $q$ is strictly decreasing in $R$. The proof proceeds within six steps. Again, we use the shortcuts $\beta_i := \beta(\alpha_i)$ and $\delta_i := \delta(\alpha_i)$.

*Step 1:* The implicit function theorem yields $\frac{dq}{dR} = -\frac{\partial \Phi/\partial \alpha}{\partial \Phi/\partial q}$, where $\partial \Phi/\partial q > 0$ by Lemma 1. Hence,

$$\text{sign}(dq/dR) = -\text{sign}(\partial \Phi/\partial R). \quad (B.6)$$

*Step 2:* Starting from (8) and using

$$\frac{\partial \beta(\alpha)}{\partial R} = -\frac{\alpha^2 e^{-\alpha R}}{(1 - e^{-\alpha R})^2} = -\beta(\alpha)\delta(\alpha),$$

differentiate $\Phi$ with respect to $R$:

$$\frac{\partial \Phi}{\partial R} = \frac{q(1 + q)}{[(1 + q)\beta - \alpha]^2} \cdot (\partial \beta_2/\partial R \cdot [(1 + q)\beta_1 - \alpha] - [(1 + q)\beta_2 - q\alpha_2]\delta_1/\partial R)$$

$$= \frac{q(1 + q)}{[(1 + q)\beta - \alpha]^2} \cdot [\beta_2\delta_1(\beta_1 - \delta_2) - q\beta_1\delta_2(\beta_2 - \delta_1)].$$

Thus, from equation (B.6)

$$\frac{dq}{dR} < 0 \iff \beta_2\delta_1(\beta_1 - \delta_2) > q\beta_1\delta_2(\beta_2 - \delta_1). \quad (B.7)$$

*Step 3:* Remember that $\beta > \alpha > 0$ is increasing in $\alpha$ and $\delta = \beta - \alpha$ is decreasing in $\alpha$. For $\alpha_1 \leq \alpha_2$, this implies $\beta_2 - \delta_1 = \beta_2 - \beta_1 + \alpha_1 > 0$. For $\alpha_1 > \alpha_2$, this implies $\beta_1 - \delta_2 = \beta_1 - \beta_2 + \alpha_2 > 0$. Now consider two cases. If $\beta_2 - \delta_1 \leq 0$, the right hand side of inequality (B.7) will be negative and, hence, $\frac{dq}{dR} < 0$. If $\beta_2 - \delta_1 > 0$, then

$$\frac{dq}{dR} < 0 \iff \Psi(R) := \frac{\beta_2\delta_1(\beta_1 - \delta_2)}{\beta_1\delta_2(\beta_2 - \delta_1)} > q. \quad (B.8)$$

\[\text{Note that } \beta_2 - \delta_1 > 0 \text{ for sufficiently high } R. \text{ This follows from } \lim_{R \to \infty} (\beta_2 - \delta_1) = \lim_{R \to \infty} (\beta_2 - \beta_1 - \alpha_1) - \alpha_2 > 0, \text{ since } \beta(\alpha) = \frac{\alpha}{1 - e^{-\alpha R}} \to \alpha \text{ as } R \to \infty.\]
**Step 4:** Now we show that

\[
\lim_{R \to 0} \Psi(R) = 1 \quad \text{and} \quad \frac{\partial \Psi}{\partial R} < 0 \iff \alpha_1 > \alpha_2.
\] (B.9)

First we compute

\[
\lim_{R \to 0} \Psi(R) = \lim_{R \to 0} \frac{\beta_2}{\delta_2} \cdot \lim_{R \to 0} \frac{\delta_1}{\beta_1} \cdot \lim_{R \to 0} \frac{\beta_1 - \delta_2}{\beta_2 - \delta_1}.
\]

Remember that \(\beta(\alpha) = \frac{\alpha}{1-e^{-\alpha R}} = \frac{\alpha e^{\alpha R}}{e^{\alpha R}-1}\) and \(\delta(\alpha) = e^{-\alpha R}\beta(\alpha) = \frac{\alpha}{e^{\alpha R}-1}\). Thus \(\lim_{R \to 0} \frac{\beta}{\delta} = \lim_{R \to 0} e^{\alpha R} = 1\) and \(\lim_{R \to 0} \frac{\delta}{\beta} = \lim_{R \to 0} e^{-\alpha R} = 1\). Moreover, for \(i, j \in \{1, 2\}\) and \(i \neq j\),

\[
\beta_i - \delta_j = \frac{\alpha_i e^{(\alpha_i + \alpha_j)R} - \alpha_j e^{\alpha_i R} - \alpha_j e^{\alpha_i R} + \alpha_j}{(e^{\alpha_i R} - 1)(e^{\alpha_j R} - 1)}.
\]

Using the last equation and applying l’Hospital’s rule twice, compute

\[
\lim_{R \to 0} \frac{\beta_1 - \delta_2}{\beta_2 - \delta_1} = \lim_{R \to 0} \frac{\alpha_1 e^{(\alpha_1 + \alpha_2)R} - \alpha_1 e^{\alpha_1 R} - \alpha_2 e^{\alpha_1 R} + \alpha_2}{\alpha_2 e^{(\alpha_1 + \alpha_2)R} - \alpha_2 e^{\alpha_1 R} - \alpha_1 e^{\alpha_2 R} + \alpha_1} = \lim_{R \to 0} \frac{\alpha_1 (\alpha_1 + \alpha_2) e^{(\alpha_1 + \alpha_2)R} - \alpha_1^2 e^{\alpha_1 R} - \alpha_2 \alpha_1 e^{\alpha_1 R}}{\alpha_2 (\alpha_1 + \alpha_2) e^{(\alpha_1 + \alpha_2)R} - \alpha_2^2 e^{\alpha_1 R} - \alpha_1 \alpha_2 e^{\alpha_1 R}} = \frac{\alpha_1 + \alpha_2}{\alpha_2} \cdot \lim_{R \to 0} \frac{(\alpha_1 + \alpha_2)^2 e^{(\alpha_1 + \alpha_2)R} - \alpha_1^2 e^{\alpha_1 R} - \alpha_2^2 e^{\alpha_1 R}}{\alpha_2^2 e^{(\alpha_1 + \alpha_2)R} - \alpha_1 \alpha_2 e^{\alpha_1 R}} = \frac{\alpha_1 \alpha_2 (\alpha_1 + \alpha_2)}{\alpha_2 \alpha_1 (\alpha_2 + \alpha_1)} = 1.
\]

Now, using that \(\phi(\alpha) = 2\beta(\alpha) - \alpha = \beta(\alpha) + \delta(\alpha)\) is positive and \(\frac{\partial \beta(\alpha)}{\partial R} = \frac{\partial \delta(\alpha)}{\partial R} = -\beta(\alpha)\delta(\alpha)\), compute

\[
\frac{\partial \Psi}{\partial R} = \frac{1}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\beta_2 \delta_2(\beta_1 - \delta_2) + \beta_2 \alpha_1 \beta_1 (\beta_1 - \delta_2) + \beta_2 \alpha_1 (\beta_1 \beta_1 - \beta_2 \delta_2)] [\beta_1 \delta_2(\beta_2 - \delta_1)]
\]

\[
+ \frac{[\beta_2 \delta_2(\beta_1 - \delta_2)] [\beta_1 \delta_2(\beta_2 - \delta_1) + \beta_1 \delta_2 \beta_2 (\beta_2 - \delta_1) + \beta_1 \delta_2 (\beta_2 \delta_2 - \beta_1 \delta_1)]}{\beta_1 \delta_2[\beta_1 \delta_2(\beta_2 - \delta_1)]^2}
\]

\[
\cdot [\phi(\alpha_1) - \phi(\alpha_2)] - \frac{\beta_1 \beta_2 \delta_1 \delta_2}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\phi(\alpha_1) - \phi(\alpha_2)] - \frac{\beta_1 \beta_2 \delta_1 \delta_2}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\phi(\alpha_1) - \phi(\alpha_2)] - \frac{\beta_1 \beta_2 \delta_1 \delta_2}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\phi(\alpha_1) - \phi(\alpha_2)]
\]

\[
\frac{\alpha_1 \beta_2 + \alpha_2 \beta_1 - \alpha_1 \alpha_2}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\phi(\alpha_2) - \phi(\alpha_1)] - \frac{\beta_1 \delta_2(\beta_2 - \delta_1)}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\phi(\alpha_2) - \phi(\alpha_1)] - \frac{\beta_1 \delta_2(\beta_2 - \delta_1)}{[\beta_1 \delta_2(\beta_2 - \delta_1)]^2} \cdot [\phi(\alpha_2) - \phi(\alpha_1)]
\]
Thus, \( \frac{d\Psi}{dR} < 0 \Leftrightarrow \alpha_1 > \alpha_2 \), since \( \phi \) is strictly increasing in \( \alpha \) by Lemma 5.

**Step 5:** Now we show that

\[
\lim_{R \to \infty} q = 0 \quad \text{for} \quad \alpha_1 > \alpha_2.
\]  

(B.10)

In order to see this, define

\[
a := a(R) := \frac{\theta_2 \delta(\alpha_1)}{\theta_1 \delta(\alpha_2)} = \frac{\theta_2 \alpha_1}{\theta_1 \alpha_2} \cdot \frac{1-e^{-\alpha_2 R}}{1-e^{-\alpha_1 R}} > 0
\]

and

\[
b := b(R) := \frac{\theta_1 \beta(\alpha_2) - \theta_2 \beta(\alpha_1)}{2 \theta_1 \delta(\alpha_2)} = \frac{1}{2e^{-\alpha_2 R}} \left[ 1 - \frac{e^{-\alpha_2 R}}{1-e^{-\alpha_1 R}} \cdot \frac{\theta_2 \alpha_1}{\theta_1 \alpha_2} \right].
\]

(B.12)

Thus \( q = \sqrt{a + b^2} - b \) by equation (A.1). Since \( \alpha_1 > \alpha_2 \), equation (B.11) implies that \( a \to 0 \) as \( R \to \infty \). Moreover, since \( \frac{\theta_1}{\theta_2} \geq \frac{\alpha_1}{\alpha_2} \) or equivalently \( 1 \geq \frac{\theta_2 \alpha_1}{\theta_1 \alpha_2} \), equation (B.12) implies that \( b \to \infty \) as \( R \to \infty \). Hence, for \( R \) sufficiently high, \( b > 0 \) and

\[
0 \leq q = \sqrt{a + b^2} - b \leq \sqrt{a} + \sqrt{b^2} - b = \sqrt{a} \to 0 \quad \text{for} \quad R \to \infty.
\]

**Step 6:** Finally we show that \( \frac{d\Psi}{dR} < 0 \). Since \( \lim_{R \to 0} \Psi(R) = 1 > \theta_2/\theta_1 = \lim_{R \to 0} q \) by equation (B.9) and Lemma 4, respectively, \( q \) is strictly decreasing for \( R \) small enough by equivalence (B.8). But then \( q \) must be strictly decreasing for all \( R > 0 \). For \( \alpha_1 \leq \alpha_2 \), this is trivial because then \( \Psi \) is non-decreasing in \( R \). For \( \alpha_1 > \alpha_2 \), suppose to the contrary that there would be some \( \tilde{R} \) such that \( \frac{d\Psi}{dR}|_{R=\tilde{R}} \geq 0 \). Then, again by equivalence (B.8), \( q \geq \Psi(\tilde{R}) \) and, since \( \Psi \) is decreasing for all \( R > 0 \) by (B.9), \( q \) would have to be increasing for all \( R \geq \tilde{R} \). This however would contradict the fact that \( \lim_{R \to \infty} q = 0 \) by equation (B.10).

**Part (b):** Note that \( 1 < \frac{\theta_1}{\theta_2} < \frac{\alpha_1}{\alpha_2} \) implies \( \alpha_1 > \alpha_2 \). We start with the proof of statement (ii). Again, we proceed within six steps. Steps 1 to 4 are identical to the corresponding steps in the proof of part (a). Note that – just like equivalence (B.8) – the analysis yields

\[
\frac{dq}{dR} \geq 0 \quad \Leftrightarrow \quad \Psi(R) := \frac{\beta_2 \delta_1 (\beta_1 - \delta_2)}{\beta_1 \delta_2 (\beta_2 - \delta_1)} \leq q.
\]

(B.13)

with equality on one side if and only if equality on the second side, too.

**Step 5':** Now we show that

\[
\lim_{R \to \infty} q = \infty.
\]

(B.14)

In order to see this, proceed exactly as in step 5 in the proof of Proposition 3. However, since now \( \frac{\theta_1}{\theta_2} < \frac{\alpha_1}{\alpha_2} \) or equivalently \( 1 < \frac{\theta_2 \alpha_1}{\theta_1 \alpha_2} \), equation (B.12) implies that \( b \to -\infty \) as \( R \to \infty \). Hence, for \( R \) sufficiently high, \( b < 0 \) and

\[
q = \sqrt{a + b^2} - b \geq \sqrt{b^2} - b = -2b \to \infty \quad \text{for} \quad R \to \infty.
\]

**Step 6':** Since \( \lim_{R \to 0} \Psi(R) = 1 > \theta_2/\theta_1 = \lim_{R \to 0} q \) by (B.9) and Lemma 4, respectively, \( q \) is strictly decreasing for \( R \) small enough by equivalence (B.13). However, since \( \Psi \) is decreasing for all \( R > 0 \) by (B.9) but \( \lim_{R \to \infty} q = \infty \) by equation (B.14), in combination with the intermediate
value theorem equivalence (B.13) also implies that there must be a unique $R_0 > 0$ such that
\[
\frac{\delta q}{\delta R} \geq 0 \iff R \geq R_0 \quad \text{(with equality if and only if $R = R_0$)}.
\]
This finishes the proof of statement (ii). Statement (i) follows immediately from (ii), again
taking into account that $\lim_{R \to 0} \Psi(R) = 1 > \theta_2/\theta_1 = \lim_{R \to 0} q$ by (B.9) and Lemma 4, respectively.

\[\square\]
C Numerical Results for CRRA-Preferences

C.1 Influence of the Own Degree of Risk Aversion

![Graphs showing q as a function of r2 for different values of r1 and θ1, θ2.](image)

(a) θ1 = θ2 = 1

(b) θ1 = 2, θ2 = 1

(c) θ1 = 1, θ2 = 2

Figure C.1 q as a function of r2 for R = 200
Figure C.2  \(q\) as a function of \(r_2\) for \(R = 1,000\)
C.2 Influence of the Opponent’s Degree of Risk Aversion

Figure C.3 $q$ as a function of $r_1$ for $R = 200$
Figure C.4  $q$ as a function of $r_2$ for $R = 1,000$
C.3 Influence of the Prize

Figure C.5 $q$ as a function of $R$ for $r_2 = 0.01$
Figure C.6  $q$ as a function of $R$ for $r_2 = 0.25$
D Complementary Statistical Results

D.1 Additional Evidence on Learning

![Graph](image1)

(a) Low prize  
(b) High prize

**Figure D.1** Average decision times across rounds

<table>
<thead>
<tr>
<th></th>
<th>Low Prize</th>
<th>High Prize</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>46.669</td>
<td>30.257</td>
</tr>
<tr>
<td><strong>Asymmetric: Low Ability</strong></td>
<td>-1.914 (3.522)</td>
<td>-2.198 (2.728)</td>
</tr>
<tr>
<td><strong>Asymmetric: High Ability</strong></td>
<td>1.794 (2.339)</td>
<td>-0.396 (5.340)</td>
</tr>
<tr>
<td><strong>Round</strong></td>
<td>-1.824*** (0.192)</td>
<td>-1.699* (0.180)</td>
</tr>
<tr>
<td><strong>Round x Low Ability</strong></td>
<td>0.154 (0.249)</td>
<td>0.241 (0.215)</td>
</tr>
<tr>
<td><strong>Round x High Ability</strong></td>
<td>-0.223 (0.223)</td>
<td>0.033 (0.481)</td>
</tr>
</tbody>
</table>

**Observations** 3,840 1,920  
**R²** 0.157 0.040

**Note:** Robust standard errors in parentheses, clustered at the session level.  
Significance level: *** (1%), ** (5%), * (10%).

**Table D.6** Panel regression results for decision times.

![Graph](image2)

(a) Low prize  
(b) High prize

**Figure D.2** Fraction of subjects using the example calculator across rounds
<table>
<thead>
<tr>
<th></th>
<th>Low Prize</th>
<th>High Prize</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>SE</td>
</tr>
<tr>
<td>Constant</td>
<td>0.250</td>
<td>(0.214)</td>
</tr>
<tr>
<td>Asymmetric: Low Ability</td>
<td>0.183</td>
<td>(0.333)</td>
</tr>
<tr>
<td>Asymmetric: High Ability</td>
<td>0.781***</td>
<td>(0.229)</td>
</tr>
<tr>
<td>Round -0.128** (0.014)</td>
<td>-0.109** (0.012)</td>
<td></td>
</tr>
<tr>
<td>Round × Low Ability</td>
<td>0.024</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Round × High Ability</td>
<td>-0.020</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,840</td>
<td>1,920</td>
</tr>
<tr>
<td>Pseudo $R^2$</td>
<td>0.092</td>
<td>0.030</td>
</tr>
</tbody>
</table>

*Note: Robust standard errors in parentheses, clustered at the session level.*

Significance level: *** (1%), ** (5%), * (10%).

Table D.7 Logit regression results for use of the example calculator

### D.2 Results for Matches with Homogeneous Risk Aversion

In the main text, we have focused on matches where the degree of risk aversion of the two subjects differs. To provide a complete picture of our results, we here report on the remaining matches in which subjects have chosen the safe option equally often in the first part of the experiment and thus have a comparable degree of risk aversion.

In treatment *Symmetric*, this implies that the contest is fully symmetric. Pooling all rounds, 120 (55) contests were played for the low (high) prize in this constellation. In each case, only three pairs achieved equal winning probabilities. Still, in half of those matches, winning probabilities were at most 65:35 (60:40).

In treatment *Asymmetric*, 39 (18) contests were played for the low (high) prize with contestants of similar risk aversion (pooling all rounds). In 30 (14) of those contests, the more able contestant achieved the higher probability of winning. Indeed, the mean winning probability of the more able contestant equals 0.73 (0.71) with the low (high) prize and is significantly larger than 0.5 for each prize (one-sided t-test, $p < 0.001$).

For late decisions, the more able contestant achieved the higher probability of winning in 12 out of 21 contests for the low prize and in 8 out of 12 contests for the high prize.

Using an OLS regression with standard errors clustered at the session level, we find no significant impact of the prize or the common degree of risk aversion on the more able contestant’s probability of winning. The results are available from the authors upon request.
### D.3 Complementary Results on the Probability of Winning

#### Table D.8 Marginal Effects of Ability Compared to Treatment Symmetric.

<table>
<thead>
<tr>
<th></th>
<th>Low Prize</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_p$ S - 3</td>
<td>S - 4</td>
<td>S - 5</td>
<td>S - 6</td>
<td>S - 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low Ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-0.264***</td>
<td>(-0.091)</td>
<td>-0.465***</td>
<td>(0.083)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-0.219*** -0.253***</td>
<td>(-0.056)</td>
<td>(-0.056)</td>
<td>-0.377*** -0.364***</td>
<td>(0.062)</td>
<td>(0.054)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-0.174*** -0.208*** -0.242***</td>
<td>(-0.041)</td>
<td>(-0.026)</td>
<td>(-0.041)</td>
<td>-0.288*** -0.276*** -0.263***</td>
<td>(0.057)</td>
<td>(0.030)</td>
<td>(0.036)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>-0.129** -0.163*** -0.197*** -0.231***</td>
<td>(-0.063)</td>
<td>(-0.043)</td>
<td>(-0.043)</td>
<td>(-0.061)</td>
<td>-0.200*** -0.188*** -0.175*** -0.162***</td>
<td>(0.072)</td>
<td>(0.037)</td>
<td>(0.019)</td>
<td>(0.046)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-0.084 -0.118 -0.152** -0.186** -0.220**</td>
<td>(-0.100)</td>
<td>(-0.082)</td>
<td>(-0.075)</td>
<td>(-0.081)</td>
<td>(-0.097)</td>
<td>-0.112</td>
<td>-0.100</td>
<td>-0.087** -0.074</td>
<td>-0.061</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.181***</td>
<td>(0.035)</td>
<td>0.189**</td>
<td>(0.083)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.171*** 0.238***</td>
<td>(0.029)</td>
<td>(0.023)</td>
<td>0.210*** 0.235***</td>
<td>(0.052)</td>
<td>(0.066)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.161*** 0.228*** 0.296***</td>
<td>(0.044)</td>
<td>(0.019)</td>
<td>(0.022)</td>
<td>0.231*** 0.256*** 0.281***</td>
<td>(0.051)</td>
<td>(0.033)</td>
<td>(0.054)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.151** 0.218*** 0.286*** 0.353***</td>
<td>(0.066)</td>
<td>(0.041)</td>
<td>(0.024)</td>
<td>(0.033)</td>
<td>0.252*** 0.276*** 0.301*** 0.326***</td>
<td>(0.082)</td>
<td>(0.044)</td>
<td>(0.026)</td>
<td>(0.053)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.141 0.208*** 0.276*** 0.343*** 0.410***</td>
<td>(0.092)</td>
<td>(0.066)</td>
<td>(0.045)</td>
<td>(0.037)</td>
<td>(0.049)</td>
<td>0.272*** 0.297*** 0.322*** 0.347*** 0.372***</td>
<td>(0.122)</td>
<td>(0.083)</td>
<td>(0.050)</td>
<td>(0.038)</td>
</tr>
</tbody>
</table>

**Note:** $S_p$ denotes the own (the opponent’s) number of safe choices. Standard errors in parentheses, calculated using the delta method. Significance levels: *** (1%), ** (5%), * (10%).
<table>
<thead>
<tr>
<th>Specification</th>
<th>Winning Probability of the Venturesome</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td>Coef.</td>
<td>SE</td>
<td>Coef.</td>
</tr>
<tr>
<td>Constant</td>
<td>0.441***</td>
<td>(0.015)</td>
<td>0.425***</td>
</tr>
<tr>
<td>Ability x Prize x Δ(S)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symm. x 200 x 1</td>
<td>-0.281**</td>
<td>(0.041)</td>
<td>-0.253***</td>
</tr>
<tr>
<td>Symm. x 200 x 2</td>
<td>-0.165***</td>
<td>(0.038)</td>
<td>-0.134***</td>
</tr>
<tr>
<td>Symm. x 200 x 3</td>
<td>-0.131***</td>
<td>(0.031)</td>
<td>-0.095***</td>
</tr>
<tr>
<td>Symm. x 200 x 4</td>
<td>-0.099***</td>
<td>(0.019)</td>
<td>-0.018</td>
</tr>
<tr>
<td>Low x 200 x 1</td>
<td>0.559***</td>
<td>(0.015)</td>
<td>0.623***</td>
</tr>
<tr>
<td>Low x 200 x 2</td>
<td>0.238**</td>
<td>(0.052)</td>
<td>0.208**</td>
</tr>
<tr>
<td>Low x 200 x 3</td>
<td>0.149***</td>
<td>(0.041)</td>
<td>-0.118***</td>
</tr>
<tr>
<td>Low x 200 x 4</td>
<td>-0.093*</td>
<td>(0.018)</td>
<td>-0.096***</td>
</tr>
<tr>
<td>Low x 1000 x 1</td>
<td>0.559***</td>
<td>(0.015)</td>
<td>0.570**</td>
</tr>
<tr>
<td>Low x 1000 x 2</td>
<td>0.258**</td>
<td>(0.025)</td>
<td>0.285***</td>
</tr>
<tr>
<td>Low x 1000 x 3</td>
<td>0.270**</td>
<td>(0.039)</td>
<td>0.299**</td>
</tr>
<tr>
<td>Low x 1000 x 4</td>
<td>0.274**</td>
<td>(0.038)</td>
<td>0.312**</td>
</tr>
<tr>
<td>Low x 1000 x 5</td>
<td>0.276**</td>
<td>(0.051)</td>
<td>0.348**</td>
</tr>
<tr>
<td>Low x 1000 x 6</td>
<td>0.559***</td>
<td>(0.015)</td>
<td>0.640***</td>
</tr>
<tr>
<td>Low x 1000 x 7</td>
<td>0.605***</td>
<td>(0.018)</td>
<td>0.689***</td>
</tr>
<tr>
<td>Low x 1000 x 8</td>
<td>0.315**</td>
<td>(0.043)</td>
<td>0.348**</td>
</tr>
<tr>
<td>Low x 1000 x 9</td>
<td>0.360***</td>
<td>(0.029)</td>
<td>0.396***</td>
</tr>
<tr>
<td>Low x 1000 x 10</td>
<td>0.370**</td>
<td>(0.020)</td>
<td>0.407***</td>
</tr>
<tr>
<td>Low x 1000 x 11</td>
<td>0.453***</td>
<td>(0.071)</td>
<td>0.540***</td>
</tr>
<tr>
<td>High x 200 x 1</td>
<td>0.559***</td>
<td>(0.015)</td>
<td>0.570**</td>
</tr>
<tr>
<td>High x 200 x 2</td>
<td>0.258**</td>
<td>(0.025)</td>
<td>0.285***</td>
</tr>
<tr>
<td>High x 200 x 3</td>
<td>0.270**</td>
<td>(0.039)</td>
<td>0.299**</td>
</tr>
<tr>
<td>High x 200 x 4</td>
<td>0.274**</td>
<td>(0.038)</td>
<td>0.312**</td>
</tr>
<tr>
<td>High x 200 x 5</td>
<td>0.276**</td>
<td>(0.051)</td>
<td>0.348**</td>
</tr>
<tr>
<td>High x 200 x 6</td>
<td>0.559***</td>
<td>(0.015)</td>
<td>0.640***</td>
</tr>
<tr>
<td>High x 200 x 7</td>
<td>0.605***</td>
<td>(0.018)</td>
<td>0.689***</td>
</tr>
<tr>
<td>High x 200 x 8</td>
<td>0.315**</td>
<td>(0.043)</td>
<td>0.348**</td>
</tr>
<tr>
<td>High x 200 x 9</td>
<td>0.360***</td>
<td>(0.029)</td>
<td>0.396***</td>
</tr>
<tr>
<td>High x 200 x 10</td>
<td>0.370**</td>
<td>(0.020)</td>
<td>0.407***</td>
</tr>
<tr>
<td>High x 200 x 11</td>
<td>0.453***</td>
<td>(0.071)</td>
<td>0.540***</td>
</tr>
<tr>
<td>S</td>
<td>0.046***</td>
<td>(0.013)</td>
<td>0.048***</td>
</tr>
</tbody>
</table>

Demographic Controls: No, Yes
Questionnaire Controls: No, Yes
Observations: 1,243

Note: Δ(S) = # Safe Choices Opponent - # Safe Choices
Robust standard errors in parentheses, clustered at the session level.
Significance level: *** (1%), ** (5%), * (10%).

Table D.9 Impact of difference in risk aversion (as categorical variable) on the Venturesome's probability of winning.
<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Winning Probability of the Venturesome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification</td>
<td>(1)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.410***</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
</tr>
<tr>
<td>Low Ability</td>
<td>-0.311**</td>
</tr>
<tr>
<td></td>
<td>(0.090)</td>
</tr>
<tr>
<td>High Ability</td>
<td>0.312***</td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
</tr>
<tr>
<td>High Prize</td>
<td></td>
</tr>
<tr>
<td>× Symmetric</td>
<td>0.140*</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
</tr>
<tr>
<td>× Low Ability</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
</tr>
<tr>
<td>× High Ability</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
</tr>
<tr>
<td># Safe Choices</td>
<td></td>
</tr>
<tr>
<td>Opponent - # Safe Choices</td>
<td>0.052</td>
</tr>
<tr>
<td>× Symmetric × Low R</td>
<td>(0.028)</td>
</tr>
<tr>
<td>× Symmetric × High R</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
</tr>
<tr>
<td>× Low Ability × Low R</td>
<td>0.087**</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
</tr>
<tr>
<td>× Low Ability × High R</td>
<td>0.057*</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
</tr>
<tr>
<td>× High Ability × Low R</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
</tr>
<tr>
<td>× High Ability × High R</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
</tr>
<tr>
<td># Safe Choices</td>
<td>0.050**</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
</tr>
<tr>
<td>Demographic Controls</td>
<td>No</td>
</tr>
<tr>
<td>Questionnaire Controls</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>1,243</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.346</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses, clustered at the session level. Significance level: *** (1%), ** (5%), * (10%).

Table D.10  Impact of difference in risk aversion (as continuous variable) on the venturesome’s probability of winning.
### D.4 Complementary Results on Effort Choices

<table>
<thead>
<tr>
<th>Specification Covariate</th>
<th>Coef.</th>
<th>SE</th>
<th>Coef.</th>
<th>SE</th>
<th>Coef.</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.281*** (0.035)</td>
<td></td>
<td>0.271*** (0.049)</td>
<td></td>
<td>0.138*** (0.045)</td>
<td></td>
</tr>
<tr>
<td>Low Ability</td>
<td>0.023 (0.039)</td>
<td></td>
<td>0.019 (0.035)</td>
<td></td>
<td>0.024 (0.034)</td>
<td></td>
</tr>
<tr>
<td>High Ability</td>
<td>0.048 (0.038)</td>
<td></td>
<td>0.044 (0.036)</td>
<td></td>
<td>0.047 (0.035)</td>
<td></td>
</tr>
<tr>
<td>High Prize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm.</td>
<td>-0.001 (0.022)</td>
<td></td>
<td>-0.001 (0.022)</td>
<td></td>
<td>-0.001 (0.022)</td>
<td></td>
</tr>
<tr>
<td>× Low Ab.</td>
<td>-0.116*** (0.007)</td>
<td></td>
<td>-0.116*** (0.007)</td>
<td></td>
<td>-0.117*** (0.008)</td>
<td></td>
</tr>
<tr>
<td>× High Ab.</td>
<td>-0.040 (0.035)</td>
<td></td>
<td>-0.040 (0.035)</td>
<td></td>
<td>-0.039 (0.036)</td>
<td></td>
</tr>
<tr>
<td># Safe Choices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm. × Low R</td>
<td>0.003 (0.015)</td>
<td></td>
<td>0.005 (0.015)</td>
<td></td>
<td>0.008 (0.013)</td>
<td></td>
</tr>
<tr>
<td>× Symm. × High R</td>
<td>-0.023*** (0.009)</td>
<td></td>
<td>-0.022*** (0.008)</td>
<td></td>
<td>-0.019*** (0.008)</td>
<td></td>
</tr>
<tr>
<td>× Low Ab. × Low R</td>
<td>-0.007 (0.012)</td>
<td></td>
<td>-0.008 (0.013)</td>
<td></td>
<td>-0.004 (0.012)</td>
<td></td>
</tr>
<tr>
<td>× Low Ab. × High R</td>
<td>-0.016* (0.009)</td>
<td></td>
<td>-0.017 (0.011)</td>
<td></td>
<td>-0.013 (0.011)</td>
<td></td>
</tr>
<tr>
<td>× High Ab. × Low R</td>
<td>-0.024*** (0.002)</td>
<td></td>
<td>-0.024*** (0.003)</td>
<td></td>
<td>-0.020*** (0.005)</td>
<td></td>
</tr>
<tr>
<td>× High Ab. × High R</td>
<td>-0.009 (0.007)</td>
<td></td>
<td>-0.009 (0.008)</td>
<td></td>
<td>-0.006 (0.010)</td>
<td></td>
</tr>
<tr>
<td># Safe Choices Opponent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm. × Low R</td>
<td>0.006 (0.006)</td>
<td></td>
<td>0.006 (0.006)</td>
<td></td>
<td>0.006 (0.007)</td>
<td></td>
</tr>
<tr>
<td>× Symm. × High R</td>
<td>-0.001 (0.005)</td>
<td></td>
<td>-0.001 (0.005)</td>
<td></td>
<td>0.000 (0.006)</td>
<td></td>
</tr>
<tr>
<td>× Low Ab. × Low R</td>
<td>-0.032** (0.013)</td>
<td></td>
<td>-0.031** (0.013)</td>
<td></td>
<td>-0.034** (0.013)</td>
<td></td>
</tr>
<tr>
<td>× Low Ab. × High R</td>
<td>0.019** (0.009)</td>
<td></td>
<td>0.019** (0.009)</td>
<td></td>
<td>0.018* (0.009)</td>
<td></td>
</tr>
<tr>
<td>× High Ab. × Low R</td>
<td>-0.014** (0.005)</td>
<td></td>
<td>-0.014** (0.006)</td>
<td></td>
<td>-0.016*** (0.006)</td>
<td></td>
</tr>
<tr>
<td>× High Ab. × High R</td>
<td>-0.008 (0.009)</td>
<td></td>
<td>-0.008 (0.009)</td>
<td></td>
<td>-0.010 (0.010)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.010 (0.024)</td>
<td></td>
<td>0.011 (0.026)</td>
<td></td>
<td>0.010 (0.026)</td>
<td></td>
</tr>
<tr>
<td>NAge</td>
<td>0.003 (0.002)</td>
<td></td>
<td>0.003 (0.003)</td>
<td></td>
<td>0.003 (0.003)</td>
<td></td>
</tr>
<tr>
<td>Siblings</td>
<td>-0.001 (0.010)</td>
<td></td>
<td>-0.007 (0.007)</td>
<td></td>
<td>-0.007 (0.007)</td>
<td></td>
</tr>
<tr>
<td>NonBAsStudent</td>
<td>-0.017 (0.016)</td>
<td></td>
<td>0.005 (0.014)</td>
<td></td>
<td>0.005 (0.014)</td>
<td></td>
</tr>
<tr>
<td>NonGermanMT</td>
<td>0.012 (0.025)</td>
<td></td>
<td>-0.023 (0.034)</td>
<td></td>
<td>-0.023 (0.034)</td>
<td></td>
</tr>
<tr>
<td>ParticipationLotteries</td>
<td>-0.008 (0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ParticipationGames</td>
<td>0.010*** (0.003)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambition</td>
<td>-0.002 (0.008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generosity</td>
<td>0.007 (0.008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImportanceWinning</td>
<td>0.031*** (0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImportancePayment</td>
<td>-0.009 (0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>2,728</td>
<td>2,728</td>
<td>2,728</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.032</td>
<td>0.036</td>
<td>0.105</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Robust standard errors in parentheses, clustered at the session level. Significance level: *** (1%), ** (5%), * (10%).

Table D.11 Determinants of effort choice: All subjects.
<table>
<thead>
<tr>
<th>Specification</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td>Coef.</td>
<td>SE</td>
<td>Coef.</td>
</tr>
<tr>
<td>Constant</td>
<td>0.252*** (0.068)</td>
<td></td>
<td>0.229*** (0.082)</td>
</tr>
<tr>
<td>Low Ability</td>
<td>-0.043 (0.082)</td>
<td></td>
<td>-0.050 (0.073)</td>
</tr>
<tr>
<td>High Ability</td>
<td>0.073 (0.069)</td>
<td></td>
<td>0.066 (0.062)</td>
</tr>
<tr>
<td>High Prize</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm.</td>
<td>0.085 (0.064)</td>
<td></td>
<td>0.086 (0.062)</td>
</tr>
<tr>
<td>× Low Ab.</td>
<td>-0.005 (0.085)</td>
<td></td>
<td>-0.006 (0.087)</td>
</tr>
<tr>
<td>× High Ab.</td>
<td>-0.003 (0.045)</td>
<td></td>
<td>-0.002 (0.045)</td>
</tr>
<tr>
<td># Safe Choices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm. × Low R</td>
<td>0.006 (0.025)</td>
<td></td>
<td>0.008 (0.025)</td>
</tr>
<tr>
<td>× Symm. × High R</td>
<td>-0.007 (0.023)</td>
<td></td>
<td>-0.005 (0.025)</td>
</tr>
<tr>
<td>× Low Ab. × Low R</td>
<td>0.007 (0.023)</td>
<td></td>
<td>0.015 (0.025)</td>
</tr>
<tr>
<td>× Low Ab. × High R</td>
<td>0.027 (0.037)</td>
<td></td>
<td>0.035 (0.036)</td>
</tr>
<tr>
<td>× High Ab. × Low R</td>
<td>0.010 (0.024)</td>
<td></td>
<td>0.018 (0.025)</td>
</tr>
<tr>
<td>× High Ab. × High R</td>
<td>0.034 (0.030)</td>
<td></td>
<td>0.042 (0.029)</td>
</tr>
<tr>
<td># Safe Choices’ Opponent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm. × Low R</td>
<td>0.014 (0.023)</td>
<td></td>
<td>0.015 (0.023)</td>
</tr>
<tr>
<td>× Symm. × High R</td>
<td>-0.025 (0.021)</td>
<td></td>
<td>-0.026 (0.020)</td>
</tr>
<tr>
<td>× Low Ab. × Low R</td>
<td>0.006 (0.017)</td>
<td></td>
<td>0.006 (0.017)</td>
</tr>
<tr>
<td>× Low Ab. × High R</td>
<td>0.007 (0.038)</td>
<td></td>
<td>0.008 (0.039)</td>
</tr>
<tr>
<td>× High Ab. × Low R</td>
<td>-0.017** (0.008)</td>
<td></td>
<td>-0.016** (0.007)</td>
</tr>
<tr>
<td>× High Ab. × High R</td>
<td>-0.030* (0.017)</td>
<td></td>
<td>-0.030* (0.017)</td>
</tr>
<tr>
<td>Female</td>
<td>0.035* (0.037)</td>
<td></td>
<td>0.016 (0.038)</td>
</tr>
<tr>
<td>NAge</td>
<td>0.005* (0.003)</td>
<td></td>
<td>0.002 (0.004)</td>
</tr>
<tr>
<td>Siblings</td>
<td>-0.003 (0.012)</td>
<td></td>
<td>-0.006 (0.009)</td>
</tr>
<tr>
<td>NonBAstudent</td>
<td>-0.018 (0.039)</td>
<td></td>
<td>0.003 (0.026)</td>
</tr>
<tr>
<td>NonGermanMT</td>
<td>0.021 (0.034)</td>
<td></td>
<td>0.005 (0.040)</td>
</tr>
<tr>
<td>ParticipationLotteries</td>
<td>-0.009** (0.004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ParticipationGames</td>
<td>0.018*** (0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambition</td>
<td>0.017 (0.016)</td>
<td></td>
<td>0.006 (0.009)</td>
</tr>
<tr>
<td>Generosity</td>
<td>0.006 (0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImportanceWinning</td>
<td>0.021** (0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImportancePayment</td>
<td>-0.007 (0.004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,243</td>
<td>1,243</td>
<td>1,243</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.021</td>
<td>0.032</td>
<td>0.090</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses, clustered at the session level.
Significance level: *** (1%), ** (5%), * (10%).

Table D.12  Determinants of effort choice: Venturesome.
<table>
<thead>
<tr>
<th>Specification</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td>Coef. SE</td>
<td>Coef. SE</td>
<td>Coef. SE</td>
</tr>
<tr>
<td>Constant</td>
<td>0.356*** (0.057)</td>
<td>0.374*** (0.078)</td>
<td>0.292*** (0.081)</td>
</tr>
<tr>
<td>Low Ability</td>
<td>0.048 (0.079)</td>
<td>0.069 (0.072)</td>
<td>0.064 (0.080)</td>
</tr>
<tr>
<td>High Ability</td>
<td>0.032 (0.090)</td>
<td>0.053 (0.085)</td>
<td>0.047 (0.074)</td>
</tr>
<tr>
<td>High Prize</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm.</td>
<td>-0.082*** (0.028)</td>
<td>-0.082*** (0.027)</td>
<td>-0.085*** (0.027)</td>
</tr>
<tr>
<td>× Low Ab.</td>
<td>-0.189*** (0.027)</td>
<td>-0.189*** (0.027)</td>
<td>-0.188*** (0.027)</td>
</tr>
<tr>
<td>× High Ab.</td>
<td>0.002 (0.071)</td>
<td>0.002 (0.070)</td>
<td>0.003 (0.070)</td>
</tr>
<tr>
<td># Safe Choices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm. × Low R</td>
<td>-0.033 (0.029)</td>
<td>-0.035 (0.030)</td>
<td>-0.030 (0.031)</td>
</tr>
<tr>
<td>× Symm. × High R</td>
<td>-0.021 (0.016)</td>
<td>-0.023 (0.018)</td>
<td>-0.017 (0.020)</td>
</tr>
<tr>
<td>× Low Ab. × Low R</td>
<td>-0.047* (0.026)</td>
<td>-0.064** (0.031)</td>
<td>-0.054** (0.023)</td>
</tr>
<tr>
<td>× Low Ab. × High R</td>
<td>-0.028 (0.029)</td>
<td>-0.045 (0.032)</td>
<td>-0.035 (0.034)</td>
</tr>
<tr>
<td>× High Ab. × Low R</td>
<td>-0.050** (0.024)</td>
<td>-0.067** (0.028)</td>
<td>-0.057*** (0.011)</td>
</tr>
<tr>
<td>× High Ab. × High R</td>
<td>-0.056*** (0.017)</td>
<td>-0.073*** (0.022)</td>
<td>-0.063*** (0.015)</td>
</tr>
<tr>
<td># Safe Choices Opponent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× Symm. × Low R</td>
<td>0.030*** (0.006)</td>
<td>0.029*** (0.006)</td>
<td>0.029*** (0.005)</td>
</tr>
<tr>
<td>× Symm. × High R</td>
<td>-0.003 (0.010)</td>
<td>-0.003 (0.010)</td>
<td>-0.003 (0.010)</td>
</tr>
<tr>
<td>× Low Ab. × Low R</td>
<td>-0.048*** (0.009)</td>
<td>-0.048*** (0.009)</td>
<td>-0.048*** (0.008)</td>
</tr>
<tr>
<td>× Low Ab. × High R</td>
<td>-0.013 (0.013)</td>
<td>-0.012 (0.014)</td>
<td>-0.011 (0.014)</td>
</tr>
<tr>
<td>× High Ab. × Low R</td>
<td>-0.018*** (0.005)</td>
<td>-0.018*** (0.005)</td>
<td>-0.017*** (0.005)</td>
</tr>
<tr>
<td>× High Ab. × High R</td>
<td>0.015 (0.027)</td>
<td>0.015 (0.027)</td>
<td>0.015 (0.027)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.020 (0.033)</td>
<td>-0.017 (0.029)</td>
<td></td>
</tr>
<tr>
<td>NAge</td>
<td>0.005 (0.004)</td>
<td>0.004* (0.002)</td>
<td></td>
</tr>
<tr>
<td>Siblings</td>
<td>-0.013 (0.015)</td>
<td>-0.017 (0.013)</td>
<td></td>
</tr>
<tr>
<td>NonBAsStudent</td>
<td>-0.020 (0.040)</td>
<td>0.008 (0.032)</td>
<td></td>
</tr>
<tr>
<td>NonGermanMT</td>
<td>0.022 (0.049)</td>
<td>-0.043 (0.056)</td>
<td></td>
</tr>
<tr>
<td>ParticipationLotteries</td>
<td>-0.006 (0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ParticipationGames</td>
<td>0.000 (0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambition</td>
<td>-0.012 (0.016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generosity</td>
<td>0.005 (0.011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImportanceWinning</td>
<td>0.036*** (0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImportancePayment</td>
<td>-0.004 (0.012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,243</td>
<td>1,243</td>
<td>1,243</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.058</td>
<td>0.072</td>
<td>0.158</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses, clustered at the session level.
Significance level: *** (1%), ** (5%), * (10%).

Table D.13  Determinants of effort choice: More risk averse subjects.
E Experimental Instructions

General Instructions
This is an experiment in strategic decision-making. Thank you for your participation.

To compensate you for showing up on time you will receive

4 Euros.

If you follow these instructions, you can earn additional money depending on your own decisions, the decisions of the other participants, and chance. At the end of the experiment the total amount of money that you have earned will be paid out to you privately in cash.

From now on, we ask you to remain seated quietly at your computer desk. You may use the computer only for the experiment. Please do not communicate with other participants during the experiment. If you have any questions during the experiment, please raise your hand and wait for an experimenter to come to you. Participants who intentionally violate these rules will be asked to leave the experiment without being financially compensated.

During the experiment your decisions determine a score expressed in points. At the end of the experiment, the points you have earned in some of your decisions will determine your earnings according to the following rule:

100 points = 1 Euro.

The experiment consists of 4 parts. On the next page you receive detailed instructions for the first part of the experiment. Instructions for the second and third part of the experiment will be made available before each of the respective parts begins.
Instructions for Part 1

In the first part of the experiment, your earnings only depend on your own decisions and chance. You have to submit **10 decisions** in this part. These are listed in the following table:

<table>
<thead>
<tr>
<th>Choice</th>
<th>Option S Points</th>
<th>Option L Points</th>
<th>Dice Score</th>
<th>Your Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>2</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>3</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 4, 5, 6, 7, 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>4</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 5, 6, 7, 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>5</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 6, 7, 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>6</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 7, 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>7</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 8, 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>8</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 9, 10</td>
<td>S</td>
</tr>
<tr>
<td>9</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if 10</td>
<td>S</td>
</tr>
<tr>
<td>10</td>
<td>180</td>
<td>400, if 1</td>
<td>0, if - - -</td>
<td>S</td>
</tr>
</tbody>
</table>

In each decision, you have a choice between two options, Option S and Option L:

- Option S yields a secure final score of 180 points.

- The final score of option L depends on the throw of a 10-sided dice. For example, in the first decision option L yields 400 points, if the dice result is 1, and it yields 0 points if the result is 2, 3, 4, 5, 6, 7, 8, 9, or 10. For the other decisions, the final score of option L is determined analogously, with the probability of receiving 400 points increasing as you move down the table. Indeed, in the last decision option L yields a secure final score of 400 points.

Only one of the 10 decisions will count towards your final earnings. To determine your earnings for the first part of the experiment, one of the participants will throw a 10-sided dice twice at the end of the experiment. The result of the first throw determines the number of the decision which counts towards your earnings. Your earnings for the first part are then determined as follows:

- If you have chosen option S in the selected decision, you earn the money equivalent of 180 points.
• If you have chosen option L in the selected decision, your earnings depend on the result of the second throw of the dice. You earn the money equivalent of the points related to the result.

Please remain quiet until all participants have finished reading the instructions. An experimenter will then read them aloud. Afterwards, the first part of the experiment will begin.

**Instructions for Part 2 [Treatment Symmetric]**

For the second and third part of the experiment, we divide the participants into two groups, group A and group B. You will be informed about the group you have been assigned to on your computer screen at the beginning of the second part. You remain in the same group until the end of the experiment.

In the second part of the experiment, you make choices in **20 consecutive rounds**. In each of these rounds, you interact with one randomly selected participant from the other group. The participant you interact with is newly determined at random in each round and will henceforth be called your counterpart.

**Your decision in each round**

YOU and your COUNTERPART participate in a lottery for a prize of

\[ R = 200 \text{ points.} \]

At the beginning of each round, each of you receives, independently of the results of previous rounds, an endowment of

\[ I = 600 \text{ points.} \]

You may use this endowment to obtain lottery tickets for yourself. To do so, you may invest any integer amount between 0 and 600 points. You receive 1 lottery ticket for each point invested.

Before you make your choice, you are shown on your computer screen how often YOU and your COUNTERPART have selected option L in the first part of the experiment.

**The winner of the lottery**

After you and your counterpart have made your choices, the winner of the lottery will be determined as follows:

If neither you nor your counterpart has obtained a lottery ticket, the computer randomly draws one of the numbers 1 and 2 where both are equally likely to be drawn. In this case you receive the prize,

• if you are a member of **Group A** and the computer draws the number 1,
• if you are a member of Group B and the computer draws the number 2.

Otherwise, the computer randomly draws an integer number between 1 and the total number of lottery tickets obtained by yourself and your counterpart. Each of those numbers is equally likely to be drawn. You receive the prize,

• if you are a member of Group A and the drawn number is at most as large as the number of lottery tickets obtained by yourself.

• if you are a member of Group B and the drawn number is larger than the number of lottery tickets obtained by your counterpart.

Your final score at the end of a round

The points you invest are deducted from your endowment irrespective of the outcome of the lottery. You keep the remaining endowment. Your final score at the end of a round therefore equals

\[
\text{finalscore} = \begin{cases} 
I - \text{invested points} + R, & \text{if you win in the lottery.} \\
I - \text{invested points}, & \text{if your counterpart wins in the lottery.} 
\end{cases}
\]

At the end of each round, you are informed about (i) the number of points you and your counterpart invested, (ii) the number selected at random by the computer, (iii) the winner in the lottery in this round, (iv) your final score.

Decision support

To support you in your choice, you are provided in each round with an example calculator which you may use to test the impact of your decision and the decision of your counterpart.

The example calculator consists of 3 parts:

• With the help of the sliders you can select the points you and your counterpart might invest.

• The pie chart shows your winning probability (green part) and the winning probability of your counterpart (red part) depending on the points invested.

• The bar chart shows your final score in case of winning (left bar) and losing (right bar) in the lottery depending on the points invested.
In addition, the following table illustrates the choice situation in the second part of the experiment with the help of six fictitious examples for a participant in group A (and a counterpart in group B).

<table>
<thead>
<tr>
<th>Bsp.</th>
<th>Lottery</th>
<th>Final score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Invested Points</td>
<td>Winning numbers</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>1, 2, ..., 50</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>51, 52, ..., 100</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>1, 2, ..., 50</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>51, 52, ..., 100</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>1, 2, ..., 60</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>61, 62, ..., 90</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>1, 2, ..., 60</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>61, 62, ..., 90</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>1, 2, ..., 30</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>31, 32, ..., 90</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>1, 2, ..., 30</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>31, 32, ..., 90</td>
</tr>
</tbody>
</table>

**Your earnings in the second part of the experiment**

At the end of the 20 rounds, two rounds will be selected. The sum of the final scores you have achieved in these two rounds determines your earnings for the second part of the experiment. To determine these two rounds, one of the participants will throw a 10-sided dice twice at the end of the experiment:

- The score of the 1st throw determines one of the rounds 1 – 10.
- The score of the 2nd throw + 10 determines one of the rounds 11 – 20.

**Control questions [Treatment Symmetric]**

The following questions are intended to ensure that you have understood the instructions. Please answer to the best of your knowledge and raise your hand once you are finished. An experimenter will then come to you and peruse the answers with you.

1. Which of the following statements is true?

   - [ ] You play in each round against the same participant drawn at random.
   - [ ] You play in each round against a participant newly drawn at random from your own group.
   - [ ] You play in each round against a participant newly drawn at random from the other group.
2. What is your likelihood of winning, if you invest exactly half as many points as your counterpart?

- 1/2.
- 1/3.

3. Who wins in the lottery, if you belong to Group B, you and your counterpart have each invested 83 points, and the computer randomly draws the number 87?

- You.
- Your counterpart.

4. Who wins in the lottery, if you invest 0 points and your counterpart invests 1 point?

- You for sure.
- Your counterpart for sure.
- Depending on the random draw of the computer, either of us may win.

5. What is your final score, if you invest your entire endowment to obtain lottery tickets and you do not win in the lottery?

- 0 points
- 600 points

**Instructions for Part 3 [Treatment Symmetric]**

The third part of the experiment will be conducted in the same way as the second part with the following exceptions:

(I) The prize equals \( R = 1.000 \text{ points} \).

(II) The third part of the experiment consists of 10 rounds.

(III) Only one of the 10 rounds will count towards your final earnings. The number of this round will be determined at the end of the experiment by the throw of a 10-sided dice. You earn the money equivalent of the final score you achieved in this round.
Instructions for Part 2 [Treatment Asymmetric]

For the second and third part of the experiment, we divide the participants into two groups, group A and group B. You will be informed about the group you have been assigned to on your computer screen at the beginning of the second part. You remain in the same group until the end of the experiment.

In the second part of the experiment, you make choices in 20 consecutive rounds. In each of these rounds, you interact with one randomly selected participant from the other group. The participant you interact with is newly determined at random in each round and will henceforth be called your counterpart.

Your decision in each round

YOU and your COUNTERPART participate in a lottery for a prize of

\[ R = 200 \text{ points}. \]

At the beginning of each round, each of you receives, independently of the results of previous rounds, an endowment of

\[ I = 600 \text{ points}. \]

You may use this endowment to obtain lottery tickets for yourself. To do so, you may invest any integer amount between 0 and 600 points. The number of lottery tickets you obtain is determined as follows:

in rounds 1-10:

- participants in **Group A** receive **1 lottery ticket** for each point invested.
- participants in **Group B** receive **2 lottery tickets** for each point invested.

and in rounds 11-20:

- participants in **Group A** receive **2 lottery tickets** for each point invested.
- participants in **Group B** receive **1 lottery ticket** for each point invested.

Before you make your choice, you are shown on your computer screen

(i) how many lottery tickets YOU earn with each point YOU invest,

(ii) how many lottery tickets your COUNTERPART earns with each point your COUNTERPART invests,

(iii) how often YOU have selected option \( L \) in the first part of the experiment,

(iv) how often your COUNTERPART has selected option \( L \) in the first part of the experiment.
The winner of the lottery

After you and your counterpart have made your choices, the winner of the lottery will be determined as follows:

The computer randomly draws an integer number between 1 and the total number of lottery tickets obtained by yourself and your counterpart. Each of those numbers is equally likely to be drawn.

You receive the prize,

- if you are a member of Group A and the drawn number is at most as large as the number of lottery tickets obtained by yourself.
- if you are a member of Group B and the drawn number is larger than the number of lottery tickets obtained by your counterpart.

If neither you nor your counterpart has obtained a lottery ticket, the computer randomly draws one of the numbers 1 and 2 where both are equally likely to be drawn. In this case you receive the prize,

- if you are a member of Group A and the computer draws the number 1,
- if you are a member of Group B and the computer draws the number 2.

Your final score at the end of a round

The points you invest are deducted from your endowment irrespective of the outcome of the lottery. You keep the remaining endowment. Your final score at the end of a round therefore equals

\[
\text{finalscore} = \begin{cases} 
I - \text{invested points} + R, & \text{if you win in the lottery.} \\
I - \text{invested points}, & \text{if your counterpart wins in the lottery.}
\end{cases}
\]

At the end of each round, you are informed about

(i) the number of points you and your counterpart invested,
(ii) the number of lottery tickets you and your counterpart obtained,
(iii) the number selected at random by the computer,
(iv) the winner in the lottery in this round,
(v) your final score.
Your earnings in the second part of the experiment

At the end of the 20 rounds, two rounds will be selected. The sum of the final scores you have achieved in these two rounds determines your earnings for the second part of the experiment. To determine these two rounds, one of the participants will throw a 10-sided dice twice at the end of the experiment:

- The score of the 1st throw determines one of the rounds 1 – 10.
- The score of the 2nd throw + 10 determines one of the rounds 11 – 20.

Example calculator and examples

To support you in your choice, you are provided in each round with an example calculator which you may use to test the impact of your decision and the decision of your counterpart.

The example calculator consists of 3 parts:

- With the help of the sliders you can select the points you and your counterpart might invest.
- The pie chart shows your winning probability (green part) and the winning probability of your counterpart (red part) depending on the points invested.
- The bar chart shows your final score in case of winning (left bar) and losing (right bar) in the lottery depending on the points invested.

In addition, the following table illustrates the choice situation in the second part of the experiment with the help of six fictitious examples for a participant in group A (and a counterpart in group B).

<table>
<thead>
<tr>
<th>Example</th>
<th>Lottery</th>
<th>Final score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tickets per point</td>
<td>Invested points</td>
</tr>
<tr>
<td>1</td>
<td><strong>YOU</strong></td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td><strong>COUNTERPART</strong></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td><strong>YOU</strong></td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td><strong>COUNTERPART</strong></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td><strong>YOU</strong></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td><strong>COUNTERPART</strong></td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td><strong>YOU</strong></td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td><strong>COUNTERPART</strong></td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td><strong>YOU</strong></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td><strong>COUNTERPART</strong></td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td><strong>YOU</strong></td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td><strong>COUNTERPART</strong></td>
<td>2</td>
</tr>
</tbody>
</table>
Control questions [Treatment Asymmetric]

The following questions are intended to ensure that you have understood the instructions. Please answer to the best of your knowledge and raise your hand once you are finished. An experimenter will then come to you and peruse the answers with you.

1. Which of the following statements is true?
   - You play in each round against the same participant drawn at random.
   - You play in each round against a participant newly drawn at random from your own group.
   - You play in each round against a participant newly drawn at random from the other group.

2. How many lottery tickets can you obtain with each point you invest?
   - Always exactly 1 lottery ticket.
   - Always exactly 2 lottery tickets.
   - Either 1 or 2 lottery tickets, depending on your group and the round number.

3. How many points does your counterpart obtain with each point YOU invest?
   - No lottery ticket.
   - Either 1 or 2 lottery tickets, depending on your group and the round number.

4. What is your final score, if you invest your entire endowment to obtain lottery tickets and you do not win in the lottery?
   - 0 points
   - 600 points

5. Who wins in the lottery, if you invest 0 points and your counterpart invests 1 point?
   - You for sure.
   - Your counterpart for sure.
   - Depending on the random draw of the computer, either of us may win.
Instructions for Part 3 [Treatment Asymmetric]

The third part of the experiment will be conducted in the same way as the second part with the following exceptions:

(I) The prize equals $R = 1.000$ points.

(II) The third part of the experiment consists of 10 rounds.

(III) The number of lottery tickets participants obtain is determined as follows:

in rounds 1-5:

- participants in Group A receive 1 lottery ticket for each point invested.
- participants in Group B receive 2 lottery tickets for each point invested.

and in rounds 6-10:

- participants in Group A receive 2 lottery tickets for each point invested.
- participants in Group B receive 1 lottery ticket for each point invested.

(IV) Only one of the 10 rounds will count towards your final earnings. The number of this round will be determined at the end of the experiment by the throw of a 10-sided dice. You earn the money equivalent of the final score you achieved in this round.
References


95 Stefanie P. Herber, The Role of Information in the Application for Merit-Based Scholarships: Evidence from a Randomized Field Experiment, January 2015

96 Noemi Schmitt and Frank Westerhoff, Managing rational routes to randomness, January 2015


98 Abdylmenaf Bexheti and Besime Mustafi, Impact of Public Funding of Education on Economic Growth in Macedonia, February 2015

99 Roberto Dieci and Frank Westerhoff, Heterogeneous expectations, boom-bust housing cycles, and supply conditions: a nonlinear dynamics approach, April 2015

100 Stefanie P. Herber, Johanna Sophie Quis, and Guido Heineck, Does the Transition into Daylight Saving Time Affect Students’ Performance?, May 2015

101 Mafaïzath A. Fatoke-Dato, Impact of an educational demand-and-supply policy on girls’ education in West Africa: Heterogeneity in income, school environment and ethnicity, June 2015

102 Mafaïzath A. Fatoke-Dato, Impact of income shock on children’s schooling and labor in a West African country, June 2015

103 Noemi Schmitt, Jan Tuinstra and Frank Westerhoff, Side effects of nonlinear profit taxes in an evolutionary market entry model: abrupt changes, coexisting attractors and hysteresis problems, August 2015.

104 Noemi Schmitt and Frank Westerhoff, Evolutionary competition and profit taxes: market stability versus tax burden, August 2015.


106 Christian R. Proaño and Benjamin Lojak, Debt Stabilization and Macroeconomic Volatility in Monetary Unions under Heterogeneous Sovereign Risk Perceptions, November 2015.

107 Noemi Schmitt and Frank Westerhoff, Herding behavior and volatility clustering in financial markets, February 2016


109 Stefanie P. Herber and Michael Kalinowski, Non-take-up of Student Financial Aid: A Microsimulation for Germany, April 2016
110 Silke Anger and Daniel D. Schnitzlein, Cognitive Skills, Non-Cognitive Skills, and Family Background: Evidence from Sibling Correlations, April 2016

111 Noemi Schmitt and Frank Westerhoff, Heterogeneity, spontaneous coordination and extreme events within large-scale and small-scale agent-based financial market models, June 2016

112 Benjamin Lojak, Sentiment-Driven Investment, Non-Linear Corporate Debt Dynamics and Co-Existing Business Cycle Regimes, July 2016

113 Julio González-Díaz, Florian Herold and Diego Domínguez, Strategic Sequential Voting, July 2016

114 Stefanie Yvonne Schmitt, Rational Allocation of Attention in Decision-Making, July 2016


116 Lisa Planer-Friedrich and Marco Sahm, Why Firms Should Care for All Consumers, September 2016.

117 Christoph March and Marco Sahm, Asymmetric Discouragement in Asymmetric Contests, September 2016.

118 Marco Sahm, Advance-Purchase Financing of Projects with Few Buyers, October 2016.


120 Marco Sahm, Risk Aversion and Prudence in Contests, March 2017

121 Marco Sahm, Are Sequential Round-Robin Tournaments Discriminatory?, March 2017

122 Noemi Schmitt, Jan Tuinstra and Frank Westerhoff, Stability and welfare effects of profit taxes within an evolutionary market interaction model, May 2017

123 Johanna Sophie Quis and Simon Reif, Health Effects of Instruction Intensity – Evidence from a Natural Experiment in German High-Schools, May 2017

124 Lisa Planer-Friedrich and Marco Sahm, Strategic Corporate Social Responsibility, May 2017

125 Peter Flaschel, Matthieu Charpe, Giorgos Galanis, Christian R. Proaño and Roberto Veneziani, Macroeconomic and Stock Market Interactions with Endogenous Aggregate Sentiment Dynamics, May 2017


127 Christoph March and Marco Sahm, Contests as Selection Mechanisms: The Impact of Risk Aversion, July 2017