Rankings and Risk-Taking in the Finance Industry*

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January 21, 2016

Abstract

Rankings are a pervasive feature of the finance industry. Although they have no direct monetary consequences, rankings provide utility for intrinsic (positive self-image) and extrinsic (status) reasons. We recruit a unique subject pool of 204 financial professionals and investigate how anonymous rankings influence risk-taking in investment decisions. We find that rankings increase risk-taking because of financial professionals' desire for positive self-image. This particularly applies to underperformers, who take the highest risks. Incentivizing rankings monetarily does not further increase risk-taking. In a comparative study with 432 students we find that student behavior is not driven by rankings.

JEL: G02, G11, D03, C93

Keywords: Experimental finance, behavioral finance, rank incentives, rankings, financial professionals, investment game, framed field experiment, tournament incentives.

*We thank Loukas Balafoutas, Gary Charness, Alain Cohn, Oege Dijk, Florian Englmaier, Sascha Füllbrunn, Maximilian Germann, Fabian Herweg, Jürgen Huber, Peter Martinsson, Kurt Matzler, Stefan Palan, David Porter, Jianying Qiu, Stephanie Rosenkranz, David Schindler, Simeon Schudy, Joep Sonnemans, Rudi Stracke, Matthias Sutter, Janette Walde, Erik Wengström, Stefan Zeisberger, seminar participants at the University of Bergen, University of Innsbruck, University of Lund, University of Munich, Radboud University, and Utrecht University, as well as conference participants of ESA 2015 in Heidelberg, Experiment a BIT 2015 in Trento, Experimental Finance 2015 in Nijmegen and the eeecon Workshop 2015 in Innsbruck for very valuable comments. We are grateful to Michael Dünser, Achiel Fenneman, Felix Holzmeister, Dirk-Jan Janssen, and Melanie Prossliner for excellent research assistance. We particularly thank all financial institutions and participating professionals for the excellent collaboration and enthusiasm. Financial support from the Austrian Science Fund (FWF START-grant Y617-G11) and Radboud University is gratefully acknowledged. This study was ethically approved by the IRB of the University of Innsbruck.

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In recent years, excessive risk-taking in the finance industry has been depicted as one of the main contributors to the global financial crisis (Financial Crisis Inquiry Commission, 2011; Dewatripont and Freixas, 2012). In particular, tournament incentives and bonus schemes have been identified as some of the main drivers for excessive risk-taking in developed financial markets (Rajan, 2006; Diamond and Rajan, 2009; Bebchuk and Spamann, 2010). These tournament incentives are characterized by two major components. The first and more obvious component is that salary depends on relative performance, creating rank-dependent *monetary incentives* for outperforming others. The second and less obvious component consists of non-monetary *rank incentives*, reflecting a desire to outperform peers for other than monetary reasons. This can either be the intrinsic desire to be better than others and thereby create a positive self-image (Maslow, 1943; Bénabou and Tirole, 2003; Köszegi, 2006) or the extrinsic desire for status signalling superior performance to peers (Frank, 1985; Moldovanu et al., 2007). Rank incentives promise a non monetary utility to those at the top of the ranking and a disutility to those at the bottom (Barankay, 2015).

Rank incentives are not only implicitly relevant in tournaments but also play an important explicit role. In the finance industry, rankings, ratings, and awards are the visible hallmarks of a strong culture of relative performance and social competition. Funds are ranked or rated annually[1] and so are their managers. Awards to the "Fund Manager of the Year," the "Banker of the Year," or the "Analyst of the Year" are recurring and sought-after distinctions in many areas of finance.[2] More informally, financial professionals often compare themselves with others in their discussions about investments and their successes ("cheap talk", see Crawford, 1998), effectively ranking each other on a regular basis.

It is striking that no scientific evidence exists showing how this implicit and explicit competition for rank influences the behavior of professionals in the finance industry. This study is the first to experimentally investigate the impact of rankings on risk-taking among financial professionals. They are exposed to a highly competitive environment in their daily business and differ from student subjects in, among others, age, income, education, and experience in the industry. We conduct a framed field experiment (Harrison and List, 2004) with 204 financial professionals from major financial institutions in several OECD countries. We only recruit professionals who regularly engage in investment decisions. Methodologically, we chose an experimental approach because it allows us to design treatments which separate the effect of rank incentives from a baseline without such incentives and from monetary tournament incentives. Moreover, our experimental treatments allow for causal inference of intrinsic incentives of outperforming others, which is much more difficult to implement in analyses using secondary data. In the baseline

[1] See, e.g., http://www.morningstar.com/; http://money.usnews.com/funds/mutual-funds; http://www.bloomberg.com/news/articles/2014-01-08/glenview-s-robbins-tops-hedge-fund-ranking-with-bet-on-obamacare.

[2] See, e.g., http://www.fmya.com/; http://www.investmentawards.com; http://www.americanbanker.com/best-in-banking/; http://excellence.thomsonreuters.com/award/starmine.

treatment, participants make repeated portfolio choices between a risk-free alternative and a risky asset during eight periods. They face linear incentives and are paid according to their final wealth. In the ranking treatment everything is kept identical but, in addition, participants receive feedback on their position in an anonymous ranking after each period. The ranking itself is *not* payoff relevant. By displaying an anonymous ranking without public disclosure we test the intrinsic component of rank incentives, that is the desire for creating a positive self-image.

We hypothesize that social reference points induce financial professionals to take more risk, particularly when they fall behind in relative performance. Results from our experiment show that risk-taking in professional investment decisions is in fact strongly rank-driven. First, we find that, on average, more risk is taken when ranking is displayed. Second, we observe that, compared to outperformers, underperformers take significantly more risk to improve their rank. The observed effect is remarkable, given that we apply the mildest form of rank incentives. As extrinsic status concerns would require publicity, the observed increase in risk-taking can solely be attributed to professionals' intrinsic demand for a positive self-image.

In a first extension of the experiment, we administer a tournament treatment where the ranking is payoff relevant. Below-average performers earn nothing and above-average performers receive rank-dependent payments. We find that rank-dependent monetary incentives do not change risk-taking compared to the ranking treatment. In a second extension, we run the same experiment with 432 student subjects and find fundamentally different results. In contrast to financial professionals, risk-taking behavior of students is not driven by rankings. In a third extension, we show that, compared to student subjects, financial professionals consider it more important to win in a competitive environment. This suggests that professionals enjoy a higher utility from relative performance, which explains why professionals take more risk when they receive feedback on their rank, even if this feedback is not payoff relevant. Whether the strong focus on relative performance is shaped by business culture (Cohn et al., 2014), driven by competitive individuals self-selecting into the industry, and/or by customer-driven market forces that demand top performance (Sirri and Tufano, 1998) is not subject of this study and open for discussion. Nevertheless, our study provides clear evidence that professionals are driven by an intrinsic motive for a positive self-image and thus compete even in the absence of rank-dependent monetary incentives.

Our results have important implications. First, from a policy perspective, they suggest that regulating bonuses and tournament incentives in the finance industry may be (partly) ineffective, as social competition and rank incentives can trigger similar behavior. Second, from an employer's perspective, it is important to know that rank incentives can substitute for expensive bonuses, provided that increased risk-taking is desirable. However, this substitution may be limited if there is strong competition for talent, leading to excessive pay for top performers (Bénabou and Tirole, 2015). If increased risk-taking also increases expected returns, as in our experimental setting, the results of this study would speak in favor of rank incentives. In contrast, if increased risk-taking is not desirable, companies might want to limit or downplay rank incentives. This may particularly apply to underperformers, because our results show that this group (who are more likely to experience losses) increases risk-taking most strongly.

1 Prior Research

Next to rankings and awards, the widespread use of tournament and convex incentives in the finance industry is another manifestation of a business culture that is strongly focused on relative performance (Goetzmann et al., 2003). Brown et al. (1996) investigate fund managers' reactions to relative performance and report that mid-year losers increase fund volatility in the second half of the year in an attempt to climb up the ladder. However, it is unclear whether this behavior is driven by monetary incentives and/or by motives such as self-image and status. More generally, Rajan (2006) argues that the limited downside risk and the strong upside potential inherent in convex compensation contracts create incentives to take risks. Since the financial crisis, this critique has become stronger as too much risk can accumulate in the financial sector (Gennaioli et al., 2012). Theoretical models (Allen and Gorton, 1993; Sato, 2015) as well as experimental studies (Holmen et al., 2014; Kleinlercher et al., 2014) show that the excessive use of convex incentives may even have an impact at the macro level, leading to overpriced assets.

As outlined, tournament incentives include monetary incentives but also non monetary rank incentives as a less obvious component. Recently, there has been mounting evidence from laboratory and field experiments, documenting that rank incentives influence individuals' behavior (Azmat and Iriberri, 2010; Blanes-i-Vidal and Nossol, 2011; Tran and Zeckhauser, 2012; Bandiera et al., 2013; Delfgaauw et al., 2013; Charness et al., 2014; Barankay, 2015). The main finding from this line of literature is that rank incentives usually increase task performance, although they may also have detrimental effects. For instance, in a real-effort task experiment, Charness et al. (2014) find that rank feedback promotes unethical behavior.

Despite the substantial literature on rank incentives, which are the main focus of our study, the relationship between rank incentives and risk-taking, has barely been investigated. Roussanov (2010) shows theoretically that aversion to idiosyncratic risk is lower than aversion to aggregate risk when social comparison is introduced. Moreover, there is little experimental evidence analyzing how concerns about relative outcomes affect risk-taking. In a study loosely related to ours, Kuziemko et al. (2015) show that individuals are last-place averse. In lottery experiments, the authors find that student subjects who are last in the ranking take significantly more risk than those who are higher up. Importantly, the ranking is monetarily incentivized, leaving it unclear whether subjects react to the monetary or the rank incentives. To the best of our knowledge, there exists only one study investigating the role of rank incentives in portfolio decisions. In lab experiments with student subjects, Dijk et al. (2014) find that underperformers invest predominantly in positively skewed assets (i.e., assets that have a strong upside potential associated with low probability), while outperformers mainly choose assets with negative skewness. However, as the assets predominantly differ in their skewness and not in the first and second moments of the distribution, Dijk et al. (2014) could not measure the impact of rank incentives on risk-taking.

All of the laboratory studies investigating the role of rank incentives use student subjects. The experimental literature testing financial professionals is rather small. Across studies, the major result is that professionals' behavior may indeed differ from the behavior of standard student subjects. In particular, professionals exhibit a higher degree of myopic loss aversion (Haigh and List, 2005), herd behavior similar to standard student subjects (Cipriani and Guarino, 2009), and behavior in line with prospect theory (Abdellaoui et al., 2013). In recent studies Cohn et al. (2014, 2015) report that professionals cheat more and take less risk when primed with their professional identity rather than their private identity.

Overall, the literature shows (a) that tournaments and rankings are the most important and disputed incentive mechanisms in the finance industry, (b) that rank incentives can strongly influence individual's behavior outside the finance realm, and (c) that the behavior of financial professionals can be highly idiosyncratic and differ substantially from, e.g., student subjects due to the specific culture in the finance industry. This is the first study that investigates the role of rank incentives for risk-taking of financial professionals.

2 Experimental Design

We divided the experiment into two parts. Subjects played an investment game in the first and major part of the experiment and participated in additional tasks eliciting risk attitudes, loss aversion and personal characteristics in the second part.

2.1 The Investment Game

Over eight periods, subjects repeatedly made portfolio choices between a risk-free alternative and a risky asset. The investment game was inspired by, and resembles games of, Lohrenz et al. (2007), Bradbury et al. (2015), Ehm et al. (2014), and Huber et al. (2015).[3] In each period, the risk-free asset yielded a return of $R_f = 0.015$ (1.5 percent) and the risky asset paid an expected return of $R_m = 0.036$ (3.6 percent) with a standard deviation of 15.9 percent. As in Bradbury et al. (2015), we computed these numbers from time series of the 6-months EURIBOR for the risk-free rate[4] and from the DAX 30 for the risky asset. We calculated returns and standard

[3]We refrained from using simpler lotteries as in Gneezy and Potters (1997) or Dijk et al. (2014) in modeling the risky asset. In preparatory discussions with professionals before rolling out the experiment, we noticed the importance of not being too abstract (i.e., lotteries instead of assets) and not deviating too far from their experience with financial markets. Therefore, we presented the investment game in a finance frame, using the term "assets" and parameters from real, historical return distributions.

[4]For the time span before its implementation we used the FIBOR – Frankfurt Interbank Offered Rate.

deviations for a 20-year period from January 1, 1994 to December 31, 2013. The numbers reflect semi annual returns and standard deviations. Subjects received information about the mean and standard deviation of the return distribution but no information about the origin of the underlying data (except that they were part of historical financial market data). In each period subjects decided which fraction, $RISK$, of their current portfolio wealth, W_p, to invest in the risky asset. W_p is carried over from one period to the next. Subjects were allowed to invest up to 200 percent of W_p, meaning that the amount exceeding W_p was borrowed at the risk-free rate R_f.[5]

2.2 Main Treatments

In a between-subjects design, we randomly assigned participants to groups of six, which remained the same for the duration of the investment game. Each group played one of the two main treatments described below (BASELINE or RANKING), or an extension treatment (TOURNAMENT), which offered rank-dependent monetary payoffs. All euro amounts in the description of the experiment refer to financial professionals. In another extension we replicated the experiment with students, who received 1/3 of the stakes throughout. The designs and procedures of the two extensions are described in Sections 4.3 and 5.1.

In Treatment BASELINE, subjects faced linear incentives and allocated their portfolio in eight periods without peer feedback. They received an initial endowment of 90 euro and accumulated gains and losses depending on their investments over time. In line with Cohn et al. (2014, 2015), each subject received the payout of the investment game with a probability of 20 percent to facilitate high stakes. An increasing number of studies indicate that these commonly used payment schemes with random components do not bias risk-taking behavior in experiments (Starmer and Sugden, 1991; Cubitt et al., 1998; Hey and Lee, 2005; March et al., 2015).

In Treatment RANKING subjects received the same linear incentives as in BASELINE, but after each period we showed them an anonymous league table, detailing all group members' current wealth levels, associated rank – $RANK \in 1, 2, \ldots, 6$ – and their own position in the ranking. This was *not* incentivized and there was no public disclosure of the ranking in the end.[6]

[5]Before the investment game started, subjects had to sample 30 returns from the theoretical distribution with the above-mentioned first two moments of the distribution. The reason for this was to make them more familiar with the properties of the risky asset. As Kaufmann et al. (2013) and Bradbury et al. (2015) report, experience sampling increases decision commitment and confidence, while it can also decrease known biases such as overestimation of loss probabilities.

[6]The reason why, in addition to the ranking, we provided subjects with information on their wealth is twofold. First, it made the experimental setup much more realistic, as finance professionals are used to having instantaneous access to wealth-related performance measures. Second, demoralization could have occurred once subjects realized that their actual rank was below their desired rank but without any indication as to how much they had to catch up to reach their desired rank. When wealth is displayed along with rank, this demoralization effect is dampened – the associated mechanism is known as the path-goal model (House, 1971, 1996) – hence increasing motivation. See also Barankay (2015) regarding this approach of displaying performance along with

2.3 Additional Tasks and Questionnaire

In the second part of the experiment, we administered two additional experimental tasks, one of which was paid randomly, and survey questions. Part 2 of the instructions were handed out after all subjects had completed Part 1.

In the first task we measured risk-attitude in a standard choice list setting (Bruhin et al., 2010; Abdellaoui et al., 2011). Subjects could choose between a risky option, paying either 0 or 24 euro with equal probability, or a safe payment, which differed between 3 and 21 euro in steps of 3 euro. We also measured risk attitudes (on a Likert scale from 1 to 7) with a survey question from the German Socio-Economic Panel (SOEP; Dohmen et al., 2011).[7]

In the second task, we measured loss aversion using the procedure of Gächter et al. (2007). In six choices subjects had to decide whether to play a particular lottery or not. If they decided to play the lottery, subjects either received, with equal probability, 15 euro or a loss of X. The loss X varied from 3 to 18 euro in steps of 3 euro. If subjects decided not to play a particular lottery, they received a payout of zero. Subjects earned 18 euro as a show-up fee for participating in the experiment, which covered potential losses in the loss aversion task.

In the survey, we measured subjects' attitudes toward social comparison with three questions on social status, financial success, and relative performance, taken from Cohn et al. (2014). Furthermore, we measured CRT scores (Cognitive Reflection Test; Frederick, 2005) with slightly modified questions (see Appendix E). We also elicited the 10-item Big-5 personality traits according to Rammstedt and John (2007) and socially undesirable personality traits such as narcissism, psychopathy, and Machiavellianism (i.e., Dark Triad) using the 12-item test of Jonason and Webster (2010). Questions on demographics concluded the experiment.[8]

3 Hypotheses Development

We model a simple portfolio decision with two assets. Let us denote the expected and actual return of a risk-free asset as R_f and the expected return of a risky asset as R_m, with $R_m > R_f$. The expected return of the investor's portfolio, R_p, is a weighted average of the expected return on the two assets, i.e., $R_p(b) = bR_m + (1 - b)R_f$. Note that the standard deviation from the portfolio $\sigma_p = b\sigma_m$. Suppose that the investor's total utility from her portfolio's return $U(\cdot)$ consists of her *monetary utility* $u(\cdot)$ from the realized outcome and her *social utility* or social

rank in his field experiment.

[7]Subjects answered the question: "How do you see yourself: Are you willing to take risks or try to avoid risks?" The answers were provided on a Likert scale from 1 (not at all willing to take risks) to 7 (very willing to take risks). We modified the scale with respect to the original study of Dohmen et al. (2011) so it fitted the other questions in the survey.

[8]See Appendix C for instructions of the experiment. The questions asked in the survey were programmed in a separate z-Tree file, which will be provided upon request.

satisfaction $v(\cdot)$ from the comparison of her outcome with a social reference point s.[9] In our specification of social utility, we follow Gamba and Manzoni (2014) and Maccheroni et al. (2014) and, for simplicity, assume that the monetary utility $u(\cdot)$ is not influenced by any reference point.[10] The investor's constrained optimization problem can thus be written as

$$max_b U(R_p(b), b, s) = u(R_p(b), b) + \gamma v(R_p(b) - s), \tag{1}$$

where we assume that function $u(\cdot)$ is twice differentiable, and increasing and strictly concave in R_p, while the investor's attitude toward risk is captured by the properties of $u(\cdot)$ with respect to changes in b.[11] Parameter γ represents the investor's concern for relative performance. From the first-order condition it follows that the optimal portfolio, b^*, satisfies:

$$\frac{\partial u(R_p, b)}{\partial R_p} + \gamma \frac{\partial v(R_p, s)}{\partial R_p} = \frac{\partial u(R_p, b)}{\partial b} \left(\frac{-1}{R_m - R_f} \right). \tag{2}$$

If the investor's concern for relative performance is absent, i.e., $\gamma = 0$, either because she is not concerned or is in a situation where there is no information about relative performance, the investor's attitude toward risk will determine whether she will buy stocks on the margin or not. If $\gamma = 0$, for a risk neutral or risk seeking investor, characterized by $\partial u(R_p, b)/\partial b \geq 0$, the right-hand side of (2) will be zero or negative, respectively. Thus, the investor's utility will be increasing the larger R_p, which leads to a corner solution and therefore the optimal $\tilde{b}^* = b_{max}$, where $\tilde{b}^*$ refers to the investor's optimal choice if $\gamma = 0$. In the following, we focus on the more relevant case where the investor is risk averse, i.e., $\partial u(R_p, b)/\partial b < 0$, such that the right-hand side of (2) is positive, and an inner solution to condition (2) exists.

Now suppose that the investor is concerned about her relative performance, i.e., $\gamma > 0$. It is obvious that γ affects the investor's optimal portfolio decision. Following Gamba and Manzoni (2014) and Maccheroni et al. (2014), we assume that the social component $v(\cdot)$ is increasing in R_p, which implies that the investor enjoys being above the social reference point and dislikes being below. The following proposition summarizes our first observation (see Appendix A for proofs of all propositions in the paper).

Proposition 1 *Suppose the investor is risk averse, i.e., $\partial u(R_p, b)/\partial b < 0$, and there is information about relative performance. If the investor is concerned about her relative performance, i.e., $\gamma > 0$, and $\partial v(R_p, s)/\partial R_p > 0$ holds, her optimal portfolio is characterized by a larger share of the risky asset, i.e., $b^* > \tilde{b}^*$.*

[9] This social reference point could be the average of the outcome of others, the median, the minimum, or the maximum.

[10] We make this assumption to carve out the effects of social comparison more clearly and succinctly. By developing our propositions and hypotheses without including possible monetary reference points in $u(\cdot)$, we focus our model on the main treatment effect (RANKING v. BASELINE), where we expect that social reference points in $v(\cdot)$ are strong enough to prevail in the experimental data.

[11] In the following, for simplicity, we consider the portfolio decision in each period t excluding dynamic strategies. For notational convenience, we therefore do not index all variables with t.

Given the experimental design described in Section 2, we can operationalize Proposition 1 into a testable hypothesis. For this, note that $RISK = b \cdot 100$ with $0 \leq b \leq 2$. Based on Proposition 1 and under the assumption that subjects are concerned about their relative performance, we expect:

Hypothesis 1 *The share of risky assets in the portfolio is higher when information on ranking is provided. Specifically, RISK is higher in Treatment* RANKING *than in Treatment* BASELINE.

Next to the first derivative, the curvature of the social component $v(\cdot)$ is essential for understanding the effect of the performance comparison on the investor's optimal choice. The curvature may change at the reference point, as in Prospect Theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), or remain unchanged over the entire domain. We can therefore distinguish four cases: $\frac{\partial^2 v(R_p,s)}{\partial R_p^2} \lesseqgtr 0$ if $R_p \lesseqgtr s$ such that $v(\cdot)$ has the same curvature over the entire domain, either (a) concave or (b) convex; $\frac{\partial^2 v(R_p,s)}{\partial R_p^2} \gtreqless 0$ if $R_p \lesseqgtr s$ such that $v(\cdot)$ has a different curvature in the social loss and in the social gain domain, either (c) concave and convex, or (d) convex and concave, respectively. Case (d) describes the reflection effect known from Prospect Theory, while Case (c) describes a reversed reflection effect. All four cases imply that an investor's incentive to buy the risky asset depends on her expected relative performance, $R_p - s$. Note that Case (c) and (d) above collapse to Case (a) and (b), respectively, if the reference point is the maximally possible performance. For example, if the reference point is to be the winner in a competition, the winner reaches, but cannot exceed, the reference point to enter the social gain domain. Hence, the curvature in the social loss domain is the only relevant part of Case (c) and (d) if the social reference point is at a maximum, even in the presence of a reflection effect. The next proposition summarizes this insight.

Proposition 2 *Suppose the investor is risk averse, i.e., $\partial u(R_p, b)/\partial b < 0$, there is information about relative performance, and the investor is concerned about her relative performance, i.e., $\gamma > 0$ and $\partial v(R_p, s)/\partial R_p > 0$.*

(i) *If $v(\cdot)$ is concave in the social loss domain and in the social gain domain, the optimal portfolio is characterized by a larger share of the risky asset, the lower the investor's performance.*

(ii) *If $v(\cdot)$ is convex in the social loss domain and in the social gain domain, the optimal portfolio is characterized by a larger share of the risky asset, the higher the investor's performance.*

Even if the social reference point does not denote the maximally possible performance, the implications of Case (c) do not differ from Proposition 2 (i) if the social gain domain is smaller than the social loss domain (i.e., the reference point is closer to the maximum than to the minimum of possible outcomes) or investors are sufficiently loss averse. In that case investors with the lowest performance (in the social loss domain) invest more than investors with the highest performance (in the social gain domain). Analogously, implications of Case (d) do not differ from Proposition 2 (ii) if the social loss domain is smaller than the social gain domain (reference point is closer to the minimum) or investors are not too loss averse.[12]

To operationalize Proposition 2 into a testable hypothesis, we need evidence about the shape of the utility function. Empirical studies on this are scarce. Linde and Sonnemans (2012) find experimental evidence for a reversed reflection effect with concavity in social losses and convexity in social gains, violating Prospect Theory regarding situations of social comparison. As discussed above, this shape can have similar behavioral implications as concavity over the entire domain if the reference point is at the maximum, or close to it, or if investors are sufficiently loss averse. In fact, concavity over the entire domain is found by Vendrik and Woltjer (2007), who examined the effect of relative income on satisfaction using a large German panel (SOEP) covering the years 1984 to 2001. The authors find that utility is concave for both gains and losses, relative to the reference income, and that the level of concavity is equal for gains and losses. We therefore base our hypothesis on Case (i) of Proposition 2 and expect:

Hypothesis 2 *The share of risky assets in the portfolio is higher for underperformers when information on ranking is provided. Specifically, $RISK$ is positively related to $RANK$ in Treatment* RANKING *and unrelated to $RANK$ in Treatment* BASELINE.

4 Experiment with Financial Professionals

4.1 Implementation

We ran a high-stakes framed field experiment with 204 financial professionals (henceforth professionals) from major financial institutions in several OECD-countries.[13] We recruited professionals who were regularly confronted with competitive rankings and bonus incentives, e.g., from private banking, trading, investment banking, portfolio management, fund management, and wealth management. Of them, 89.7 percent were male, their average age was 34.9 years, and they had been working in the finance industry for 11.0 years on average.

We ran the experiments in summer 2014 and winter 2014/2015. We booked a conference room on location, set up our mobile laboratory and invited professionals to show up. Our mobile laboratory was identical to the Innsbruck EconLab at the University of Innsbruck. It consisted of laptops and partition walls on all sides for each participant, ensuring conditions as in

[12] The presence of a reflection effect makes it difficult to derive predictions for the remaining intermediate scenarios without more specific assumptions about the precise position of the social reference point and relative slopes of the functional form of the investor's social utility. As our treatment effect does not impose a specific reference point we refrain from making more explicit assumptions.

[13] We signed non disclosure agreements (NDA) for not disclosing the identity of the participating financial institutions.

regular experimental laboratories (see pictures in Appendix D). We mainly recruited members of professional associations/societies, ensuring that most sessions were populated with professionals from different institutions. With this procedure we achieved high comparability with the student sample as most professionals did not know, or barely knew, each other.

We randomized across both main treatments, BASELINE and RANKING, and the additional Treatment TOURNAMENT (see Section 4.3). In each session, in which 12 to 30 subjects participated (with 12 being the exception), we always ran at least two treatments at the same time.[14] In total, 48, 84, and 72 professionals participated in Treatments BASELINE, RANKING, and TOURNAMENT (see Section 4.3), respectively. We programmed and conducted the experiment using z-Tree (Fischbacher, 2007).

Professionals received an average payout of 54 euro for both parts of the experiment with a maximum payout of 600 euro and an average duration of 45 minutes per session. For subjects who received money in the investment game, the average payout was 146 euro for a task of 20 minutes, ensuring salient incentives for professionals. In the questionnaire, professionals reported an average annual gross salary of 91,600 euro. Accordingly, the average (maximum) hourly payoff from the experiment amounted to roughly 2.8 times (31 times) the average professional's hourly wage after taxes.[15] We therefore consider our monetary incentives to be substantial and are confident that they induced sincere behavior. Finally, we administered the payout privately by handing out sealed envelopes containing the payout from the experiment (which was public knowledge).

4.2 Results

4.2.1 General Portfolio Risk (Hypothesis 1)

We find that risk-taking is higher in Treatment RANKING with, on average, 104.1 percent invested in the risky asset compared to 87.8 percent in Treatment BASELINE. To test whether this difference is significant, we ran a random effects panel regression with AR(1) disturbance (to correct for serial autocorrelation) with subject i's invested share $RISK$ in period t as the depen-

[14] To ensure comparability, we administered the "intermediate" Treatment RANKING in all sessions and added either one or two groups of BASELINE and/or the extension Treatment TOURNAMENT. It is encouraging that we found no differences between RANKING administered alongside BASELINE and RANKING administered alongside TOURNAMENT, making us confident that our results were not due to selection effects with regard to institution or location.

[15] For this calculation, we assumed a working time of 45 hours/week for 47 weeks/year and 40 percent taxes to calculate an hourly net wage (26 euro). In our experiment, subjects' average (maximum) hourly payment was 72 (800) euro (54*60/45 and 600*60/45), resulting in 277 (3,079) percent of their salary. Haigh and List (2005) report in footnote 6 that their average traders' payment for a 25 minutes task was 40 U.S. dollars, which translates to an hourly payment of 96 U.S. dollars. Given an exchange rate of about 1.32 at the time of the study, the payment in Haigh and List (2005) is equivalent to an average hourly wage of 73 euro. Note that monetary incentives in experiments with a representative sample of the general population are less accurate, because of the high heterogeneity in subjects' salaries. In our case, the hourly payout of nearly three times the average applies to a sample with a more homogeneous salary distribution.

dent variable.[16] To account for asset- and portfolio-specific effects, we included last period's asset return, $R_{m,t-1}$, and the log-return of subject i's portfolio since the start, $R_{p,t-1}$=$ln(W_{p,t-1}/90)$, as explanatory variables. Here, $W_{p,t-1}$ indicates portfolio wealth in euro in period t-1.

Table 1: Professionals subject pool: random effects panel regression with AR(1) disturbance, testing treatment differences of subjects' percentage invested in the risky asset, $RISK$.

Dependent variable: $RISK$, percentage invested in risky asset	BASELINE	RANKING	ALL
α	89.683***	108.936***	89.683***
	(7.466)	(5.851)	(7.629)
$R_{p,t-1}$ (portfolio return)	-0.344***	-0.479***	-0.407***
	(0.091)	(0.092)	(0.064)
$R_{m,t-1}$ (asset return)	-0.273	-0.043	-0.136
	(0.175)	(0.139)	(0.109)
RANKING (dummy)			18.874**
			(9.553)
N	336	588	924
R-squared	0.083	0.100	0.103
$\chi 2$	22.552	33.275	57.765
Prob > $\chi 2$	0.000	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. RANKING (dummy) is a dummy variable for Treatment RANKING with BASELINE as the reference category. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

Columns 1 and 2 in Table 1 report the regression results for Treatments BASELINE and RANKING, respectively. We henceforth refer to these econometric specifications as "base regression" and use it throughout the paper except where explicitly stated otherwise. Note that the sample includes seven decisions per subject from periods 2 to 8 due to lagging of the return variables. Column 3 pools both treatments and adds a dummy variable for RANKING. The coefficient is significantly positive, showing that professionals generally react to rankings with increased risk-taking of 19.6 percentage points.[17]

We also find a significant negative relationship between the portfolio return $R_{p,t-1}$ and subjects' risk-taking. Professionals generally seem to decrease (increase) risk after realizing gains (losses). This behavior is related to the disposition effect (Weber and Camerer, 1998) and suggests a monetary reference point and/or nonlinear curvature in monetary incentives (i.e., in

[16]A Hausman specification test indicates that the individual-level effects are adequately modeled with a random-effects model.

[17]As a robustness check for tables 1 – 5, we use random effects panel regressions without AR(1) disturbance and clustered standard errors at group level. All results of the robustness checks can be found in Appendix B and show highly similar results.

utility function $u(\cdot)$ in Section 3).[18] We further report a negative but insignificant relationship between the last period's asset return $R_{m,t-1}$ and risk-taking in Treatment BASELINE and in the joint regression in Column 3.

Overall, we conclude that Hypothesis 1 is supported for professionals as rank incentives increase their average willingness to invest in the risky asset.

4.2.2 Rank and Risk (Hypothesis 2)

Figure 1 reports professionals' risk-taking conditional on their rank in the previous period ($RANK_{t-1}$).[19] We find that professionals at $RANK_{t-1} = 1$ invest 95 percent in the risky asset in both treatments. In Treatment RANKING, risk-taking increases in $RANK_{t-1}$. Particularly underperforming professionals ($RANK_{t-1} = 4, 5, 6$) take more risk and invest on average between 116 and 120 percent of their current wealth in the risky asset. Results are different for Treatment BASELINE, where a lack of rank information leads to similar risk-taking across all ranks. At levels between 29 and 32 percentage points, the differences in risk-taking of underperformers between Treatments BASELINE and RANKING are substantial.[20]

To test Hypothesis 2, we run the base regressions and add the variable $RANK_{t-1}$, recording subjects' rank in portfolio wealth in the previous period. For Treatment RANKING, the coefficient of $RANK_{t-1}$ in Table 2 is positive and statistically highly significant ($p = 0.001$). With anonymous rank feedback, risk-taking increases by roughly 5.7 percentage points with each rank further down the league table. As expected, without any feedback on ranking, a professional's actual rank is negatively, though insignificantly, related to risk-taking in Treatment BASELINE.

Overall, these results provide robust evidence in support of Hypothesis 2. Professionals react to rank incentives when they face low relative performance. In Treatment BASELINE without rank information, we find no correlation between relative performance and risk-taking. In line with Hypothesis 2, this implies that the difference in risk-taking between BASELINE and RANKING is larger for low rather than high relative performance. Taken together, the results for Hypotheses 1 and 2 suggest that rank incentives are a significant driver of risk-taking by professionals.

[18] Although it is not clear where such a monetary reference point would lie, a natural candidate could be the initial endowment, but other references such as the compounded expected asset return are also possible.

[19] Here, we ran our base regressions (Column 1 and 2 in Table 1) without AR(1) disturbance, but with dummy variables for each $RANK$ in $t-1$. Figure 1 reports the sum of the intercept and the coefficient of each rank dummy, reflecting the rank-specific average of $RISK$, which, in turn, controls for portfolio wealth and asset returns.

[20] The raw differences of $RISK$ between treatments BASELINE and RANKING are significant at the 5 percent level for $RANK_{t-1} = 4$ and at the 1 percent level for $RANK_{t-1} = 5$ and $RANK_{t-1} = 6$ according to Mann-Whitney U-tests (N=154).

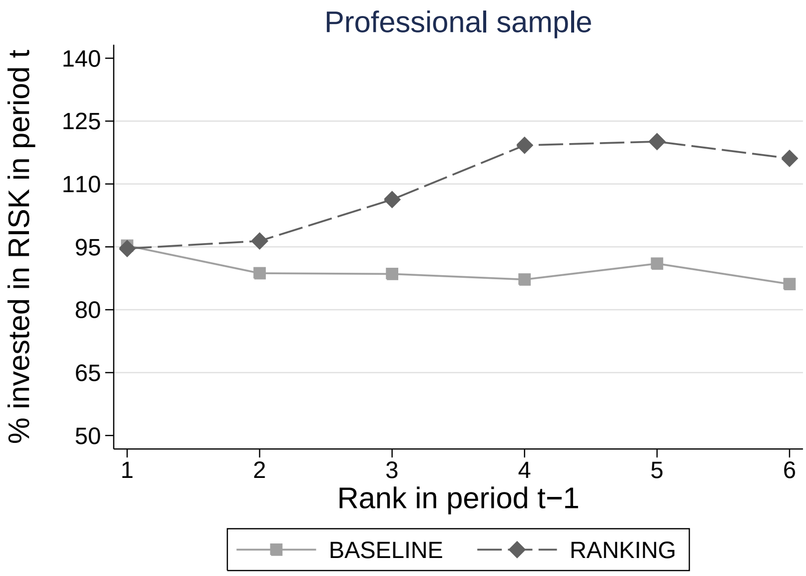

Figure 1: Professional subject pool: average percentage invested in the risky asset ($RISK$) in period t conditional on subject's rank in the previous period $t-1$ ($RANK_{t-1}$) across Treatments BASELINE and RANKING.

Table 2: Professional subject pool: random effects panel regression with AR(1) disturbance, testing the impact of subject's rank in the previous period $t-1$ ($RANK_{t-1}$) on the percentage invested in the risky asset, $RISK$.

Dependent variable: $RISK$, percentage invested in risky asset	BASELINE	RANKING
α	99.675***	88.383***
	(10.573)	(8.420)
$R_{p,t-1}$ (portfolio return)	-0.383***	-0.374***
	(0.095)	(0.097)
$R_{m,t-1}$ (asset return)	-0.252	-0.102
	(0.177)	(0.139)
$RANK_{t-1}$	-2.802	5.653***
	(2.228)	(1.697)
N	336	588
R-squared	0.109	0.129
$\chi 2$	24.475	45.087
Prob > $\chi 2$	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. $RANK_{t-1}$ indicates subject i's rank in the preceding period. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

4.3 Extension 1: Treatment TOURNAMENT

Although Treatment RANKING is sufficient to test our hypotheses, we additionally explore how the effects of non monetary rank incentives also relate to monetary incentives in a tournament setting. Theoretically, it is not clear which of the two incentives is stronger and how large the aggregate effect of the combination of non monetary and rank-dependent monetary incentives will be. This depends on subjects' subjective weighting of rank and rank-dependent monetary incentives and on the curvatures of subjects' utility functions for both types of incentives, all of which are largely unknown. We nevertheless consider an additional treatment with tournament incentives to be an important extension in view of the prevalence of bonuses and tournament-like payments in the finance industry.

Treatment TOURNAMENT equals Treatment RANKING, the only difference being that the ranking was payout relevant. Subjects who finished the investment experiment at $RANK = (4, 5, 6)$ received no payout. For the top three ranks the final wealth of all six subjects was summed up and divided as follows. The winner, $RANK = 1$, received 1/2, $RANK = 2$ received 1/3, and $RANK = 3$ earned 1/6 of the entire cake. This was done to ensure identical expected stake sizes across treatments.

Our results show that average risk-taking is highest in Treatment TOURNAMENT with 110.8 percent, exceeding risk-taking in BASELINE and RANKING by 23.0 and 6.7 percentage points, respectively. When extending Table 1 with a dummy for Treatment TOURNAMENT, we find a significantly higher level of risk-taking in TOURNAMENT compared to BASELINE (coefficient: 23.734, $p = 0.016$; see Table A1 in Appendix B). A post-estimation Wald test finds no difference between the levels of risk-taking in RANKING and TOURNAMENT (coefficient of RANKING: 19.134, $p = 0.589$).

Figure 2 also shows that rank-dependent monetary incentives in Treatment TOURNAMENT hardly change professionals' behavior relative to RANKING.[21] This finding is corroborated by the results in Table 3, where the coefficient of $RANK_{t-1}$ in Treatment TOURNAMENT is positive and highly significant, with a value of 7.764 ($p = 0.000$). As in Table 1, we find a significantly negative relationship between portfolio return $R_{p,t-1}$ and $RISK$. In addition, the coefficient of $R_{m,t-1}$ is significantly negative in Treatment TOURNAMENT.

Overall, we conclude that the monetary tournament incentives applied in our experiments seem to be of secondary importance for professionals as they do not change ranking-induced behavior compared to Treatment RANKING. We readily acknowledge that this behavioral pattern may change in the face of increased stake sizes.

[21] The raw differences of $RISK$ between TOURNAMENT and BASELINE are statistically significant at the 5 percent level for $RANK_{t-1} = 4$ and at the 1 percent level for $RANK_{t-1} = 5$ and $RANK_{t-1} = 6$ according to Mann-Whitney U-tests ($N = 140$).

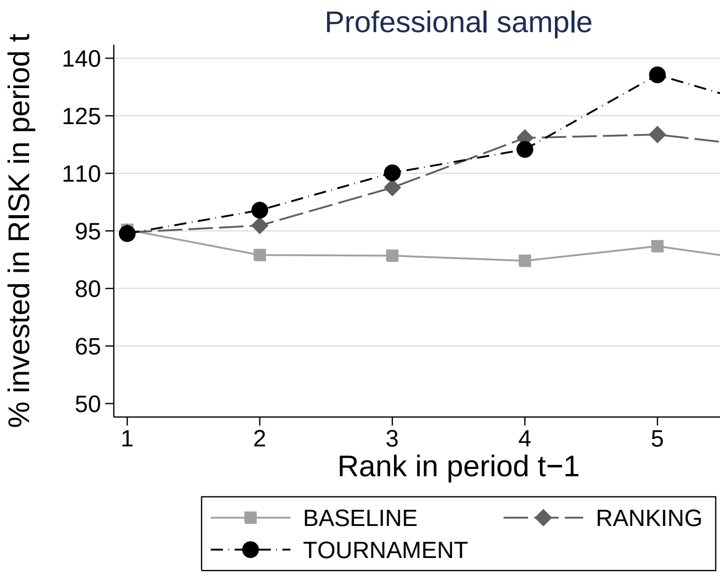

Figure 2: Professional subject pool: average percentage invested in the risky asset ($RISK$) in period t conditional on subject's rank in the previous period $t-1$ ($RANK_{t-1}$) across treatments (including Treatment TOURNAMENT).

Table 3: Professional subject pool: random effects panel regression with AR(1) disturbance, testing the impact of subject's rank in the previous period $t-1$ ($RANK_{t-1}$) on the percentage invested in the risky asset, $RISK$.

Dependent variable: $RISK$, percentage invested in risky asset	TOURNAMENT
α	86.661***
	(9.414)
$R_{p,t-1}$ (portfolio return)	-0.273***
	(0.085)
$R_{m,t-1}$ (asset return)	-0.510***
	(0.146)
$RANK_{t-1}$	7.764***
	(2.030)
N	504
R-squared	0.152
$\chi 2$	56.405
Prob > $\chi 2$	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. $RANK_{t-1}$ indicates subject i's rank in the preceding period. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

5 Extension 2: Experiment with Student Subjects

5.1 Implementation

In a second extension, we investigate whether rank-dependent behavior is unique for professionals or can be found in other subject pools as well. We therefore repeat the experiment with standard student subjects. For this, we administer the same experiment to bachelor and master students from various disciplines at the University of Innsbruck. All student experiments were run in the Innsbruck EconLab between summer 2014 and winter 2014/2015. In total, 432 students took part, 144 in each treatment. Of them, 79.9 percent were male, and the average age was 23.9 years. Of the subjects, 52.5 percent were students from the faculties of Management and of Economics. The remaining specifications were identical to the experiment with professionals except for the stake size. Similar to other studies (List and Haigh, 2005; Alevy et al., 2007; Cohn et al., 2014), we scaled down student stakes to 1/3 of the professionals' payoffs in all parts of the experiment. Average earnings were 18 euro with a maximum payout of 323 euro.

5.2 Results

5.2.1 General Portfolio Risk (Hypothesis 1)

As in the professionals' sample, we find that risk-taking is highest in Treatment TOURNAMENT with an average investment of 104.5 percent in the risky asset. The most striking difference to the professionals' sample is that $RISK$ is much lower in Treatment RANKING. With 76.9 percent, students' risk-taking in RANKING is close to the baseline of 74.0 percent (see Figure A1 in Appendix B). We test the treatment differences in Table 4, which reports a statistically insignificant coefficient of the dummy for Treatment RANKING but a highly significant coefficient of the TOURNAMENT dummy. Furthermore, a post-estimation Wald test shows a significant difference between the coefficients of RANKING and TOURNAMENT ($p = 0.000$).[22]

Overall, we cannot support Hypothesis 1 for the student sample, although rank incentives clearly matter in the professionals' sample.

5.2.2 Rank and Risk (Hypothesis 2)

Figure 3 shows treatment averages of $RISK$ conditional on the rank in the previous period for the professionals' sample (left panel) and the student sample (right panel). Table 5 provides the regression results for the student sample. In contrast to the professionals, the coefficient of $RANK_{t-1}$ in Treatment RANKING is insignificant. In Treatment TOURNAMENT, however, students' rank-dependent behavior is almost identical to that of the professionals. Here, the

[22]Compared to the professionals, we find that students invest less in the risky asset in RANKING ($\triangle = 27.2$, $p = 0.000$, $N = 228$) but not in BASELINE ($\triangle = 13.8$, $p = 0.131$, $N = 192$) nor in TOURNAMENT ($\triangle = 6.3$, $p = 0.638$, $N = 216$) according to Mann-Whitney U-tests.

Table 4: Student subject pool: random effects panel regression with AR(1) disturbance, testing treatment differences of subjects' percentage invested in the risky asset, $RISK$. For comparison the results of the professionals are shown in the left column.

Dependent variable: $RISK$, percentage invested in risky asset	ALL (Prof.)	ALL (Stud.)
α	89.849***	73.600***
	(7.653)	(4.303)
$R_{p,t-1}$ (portfolio return)	-0.390***	-0.394***
	(0.050)	(0.040)
$R_{m,t-1}$ (asset return)	-0.260***	-0.056
	(0.088)	(0.057)
RANKING (dummy)	19.134**	5.888
	(9.586)	(6.089)
TOURNAMENT (dummy)	23.734**	33.069***
	(9.873)	(6.081)
N	1428	3024
R-squared	0.114	0.097
$\chi2$	99.428	153.791
Prob > $\chi2$	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment, and $R_{m,t-1}$ is the preceding asset return. RANKING (dummy) and TOURNAMENT (dummy) are dummy variables for Treatments RANKING and TOURNAMENT, respectively, with BASELINE as the reference category. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

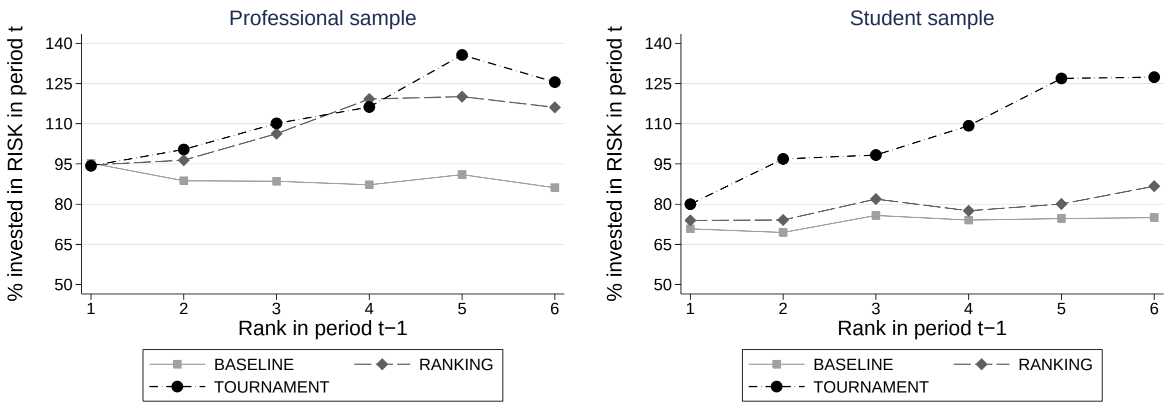

Figure 3: Professionals' (left panel) and student subject pool (right panel): average percentage invested in the risky asset ($RISK$) in period t conditional on subject's rank in the previous period $t-1$ ($RANK_{t-1}$) across treatments.

coefficient of $RANK_{t-1}$ is positive and highly significant, with a value of 10.5.[23] The findings from the student subjects also rule out learning as a possible alternative explanation for the observed rank effect in the sample of professionals. With feedback in Treatment RANKING, underperformers could "learn" that more risk-taking is rewarded with higher returns. However, as we observe no rank effect in Treatment RANKING with students, this explanation does not hold.

Table 5: Student subject pool: random effects panel regression with AR(1) disturbance, testing the impact of subject's rank in the previous period $t-1$ ($RANK_{t-1}$) on the percentage invested in the risky asset, $RISK$.

Dependent variable: $RISK$, percentage invested in risky asset	BASELINE	RANKING	TOURNAMENT
α	70.189***	73.192***	70.271***
	(6.373)	(6.569)	(7.050)
$R_{p,t-1}$ (portfolio return)	-0.417***	-0.295***	-0.211***
	(0.068)	(0.076)	(0.077)
$R_{m,t-1}$ (asset return)	-0.029	-0.090	-0.204
	(0.079)	(0.094)	(0.128)
$RANK_{t-1}$	0.972	1.630	10.458***
	(1.383)	(1.343)	(1.624)
N	1008	1008	1008
R-squared	0.096	0.049	0.079
$\chi2$	55.346	32.607	77.920
Prob > $\chi2$	0.000	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding asset return. $RANK_{t-1}$ indicates subject i's rank in the preceding period. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

For both control variables, $R_{p,t-1}$ and $R_{m,t-1}$, we report a similar pattern as in the professionals' sample. The coefficients of portfolio returns, $R_{p,t-1}$, are significantly negative in all treatments and most strongly pronounced in BASELINE. As the professionals, students decrease (increase) risk-taking after high (low) portfolio returns.

We conclude that Hypothesis 2 is not supported for the student sample. Although student behavior is often similar to that of professionals, it differs strikingly in at least one important aspect. In contrast to professionals, students do not react to rank incentives unless these are backed by rank-dependent monetary tournament incentives.

[23] Additionally, we ran Mann-Whitney U-tests and find no differences between Treatments BASELINE and RANKING ($N = 336$) with the exception of $RANK = 2$ (5 percent level). We also find significantly more risk-taking of students at all ranks, except $RANK = 1$, in TOURNAMENT compared to RANKING (at a 1 percent level, $N = 336$).

6 Extension 3: Possible Explanation for Observed Differences

It is reasonable to assume that people differ in their degree of concern for relative performance. Moreover, given the competitive business culture in the finance industry, professionals as a group may be more concerned about their relative performance than students and may thus react more strongly to feedback regarding relative performance by taking more risk. Proposition 3 summarizes this intuition on the basis of our theoretical framework in Section 3:

Proposition 3 *Suppose investor i is more concerned about her relative performance than investor j, i.e., $\gamma_i > \gamma_j \geq 0$, and there is information about relative performance. In that case her optimal portfolio is characterized by a larger share of the risky asset, i.e., $b_i^* > b_j^*$, if investors i and j are risk averse, i.e. $\partial u_k(R_p, b)/\partial b < 0$ with $k = i, j$.*

A consequence of Proposition 3 is that the more concerned an investor is about relative performance $\gamma_j \to \infty$, the less she will respond to factors that affect her monetary utility $u(\cdot)$ such as different payment schemes. An important condition for this explanation is that finance professionals are, on average, more concerned about their relative performance and social comparison than student subjects. At the group level, Proposition 3 provides an explanation for why rank incentives affect professionals more strongly than students, as shown in Section 5. To test this, we administered survey questions at the end of the experiment, measuring subjects' attitudes toward social status, financial success, and relative performance similarly to Cohn et al. (2014). Specifically, we asked:

Q1 (social status): How important is it for you what others think about you? (1: not important; 7: very important)

Q2 (financial success): Social status is primarily defined by financial success. (1: completely disagree; 7: fully agree)

Q3 (relative performance): How important is it for you to be the best at what you do? (1: not important; 7: very important)

Figure 4 reports aggregate responses for each subject pool. Although there are no differences between professionals and students in the average importance of financial success (Q2: $\triangle =$ –0.10, $p = 0.398$, $N = 636$, Mann-Whitney U-test), we observe significant differences with regard to social status and relative performance. Social status is significantly more important for professionals than for students (Q1: $\triangle = 0.40$, $p = 0.001$, $N = 636$, Mann-Whitney U-test) and "to be the best" is even more important (Q3: $\triangle = 0.73$, $p = 0.000$, $N = 294$, Mann-Whitney U-test).[24] This result supports the notion that subject-pool-specific differences in attitudes to-

[24] All subjects answered Q1 and Q2. After collecting about half of the data, we additionally asked Q3. For analyses regarding Q3, we therefore used the corresponding sub sample with $N = 294$. In another study, we administered Q1, Q2, and Q3 to other, but similarly recruited professionals ($N = 234$). The differences between the responses in the two studies are remarkably low: $\triangle_{Q1} = 0.02$, $\triangle_{Q2} = 0.08$, and $\triangle_{Q3} = 0.01$.

ward rank incentives explain the differences in rank-dependent risk-taking between professionals and students. In fact, economics and management student are closer to professionals in some of their attitudes than students with other majors (e.g., natural sciences, life sciences, humanities). When we split the student sample along these lines, we find that economics and management students consider relative performance (Q3) to be significantly more important than other students (Q3: 5.08 vs. 4.59, $\triangle = 0.49$, $p = 0.007$, $N = 192$, Mann-Whitney U-test).

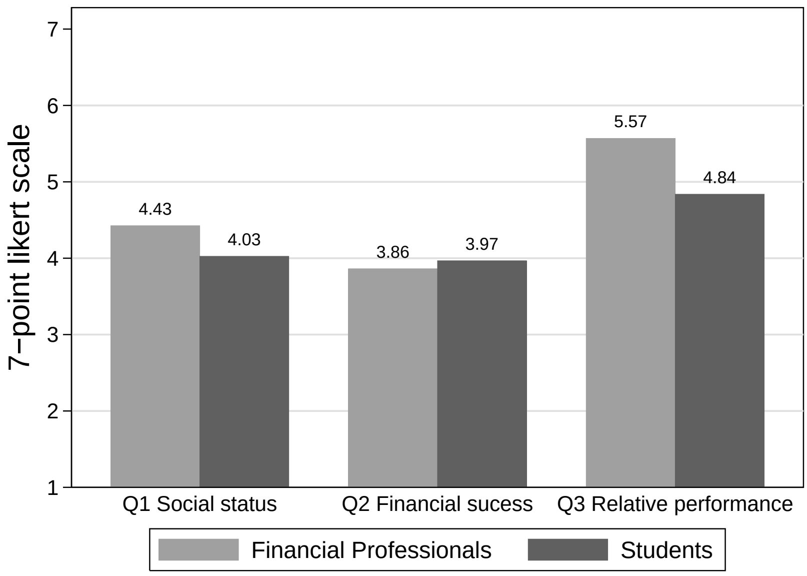

Figure 4: Answers to questions Q1 (social status), Q2 (financial success), and Q3 (relative performance). The vertical axis shows averages from answers on a Likert scale from 1 (not important or completely disagree) to 7 (very important or fully agree).

At the level of the individual, Proposition 3 predicts that when exposed to rank incentives, investors who are more concerned about their relative performance take more risk than investors who are less concerned. We therefore ran ordinary least squares regressions with a subject's average risk taken over all eight periods ($\overline{RISK}$) as dependent variable and the answers to Q1, Q2, and Q3 as independent variables. As control variables we include loss aversion, general risk attitude, CRT-score, BIG-5, and Dark Triad personality traits. We do not use the risk aversion measurement elicited with the lottery procedure due to high correlation with loss aversion.[25]

The results in Table 6 show that subjects' attitudes toward relative performance are a strong predictor for professionals' individual risk-taking. Professionals who consider being the best as

[25] We used the sub sample with non-missing answers to Q3 in these regressions. We report the same regressions without Q3 for both the sub sample and the total sample in Table A5 of Appendix B. For loss aversion we include the sum of accepted lotteries. Thus, the normalized variable $LOSS\_TOLERANCE$ takes on values from 0 (rejecting all gambles – highly loss averse) to 1 (accepting all gambles – loss seeking). For risk attitude we use the answer to the SOEP survey question 148 (see Section 2.3). For CRT_SCORE we take the number of correctly answered CRT questions, ranging from 0 to 3.

Table 6: Ordinary least squares regression on subjects' average amount invested in the risky asset, $\overline{RISK}$.

Dependent variable: $\overline{RISK}$, mean percentage invested in risky asset	Professional sample		Student sample	
	(1)	(2)	(3)	(4)
α	11.046	-6.106	35.814*	31.309
	(33.946)	(78.904)	(17.958)	(52.421)
$SOCIAL\_STATUS$	-4.758	-4.314	-2.800	-1.698
	(4.057)	(4.169)	(2.286)	(2.685)
$FINANCIAL\_SUCCESS$	0.503	1.163	0.905	0.920
	(3.688)	(4.331)	(2.449)	(2.605)
$RELATIVE\_PERFORMANCE$	10.572***	9.860**	-1.271	0.472
	(2.757)	(3.799)	(2.981)	(3.098)
$LOSS\_TOLERANCE$	35.009	31.869	52.210***	51.253***
	(27.279)	(26.378)	(17.943)	(18.102)
$GENERAL\_RISK$	9.656***	11.402***	14.083***	14.415***
	(2.892)	(3.259)	(1.680)	(1.981)
CRT_SCORE		6.746		2.186
		(6.675)		(4.058)
$BIG-5$	no	yes	no	yes
$DARK\_TRIAD$	no	yes	no	yes
N	102	102	192	192
Clusters	17	17	32	32
R-squared	0.159	0.221	0.227	0.269
F	6.680	5.548	29.978	14.497
Prob > F	0.002	0.001	0.000	0.000

Notes: *SOCIAL_STATUS*, *FINANCIAL_ SUCCESS*, and *RELATIVE_ PERFORMANCE* represent the answers to corresponding survey questions on a 7-point Likert scale (higher values indicate stronger preferences). Model (2) and Model (4) control additionally for CRT_SCORE, $BIG-5$ and $DARK\_TRIAD$. $LOSS\_TOLERANCE$ is a measure of loss attitudes (from 0 to 1; higher values indicate lower loss aversion) and $GENERAL\_RISK$ is the self-reported willingness to take risks (7-point Likert scale). ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

more important invest significantly more in the risky asset than those who consider it less important. As expected, the same variable fails to predict risk-taking behavior of students. In both samples, subjects who are less loss averse (statistically not significant for professionals, though) and generally more risk tolerant, take more risks in the investment experiment. Additionally, results remain very similar when controlling for CRT_SCORE and personality traits ($BIG-5$ and $DARK\_TRIAD$). Moreover, CRT_SCORE and all personality traits of the $BIG-5$ and the $DARK\_TRIAD$ have no impact on risk-taking among professionals.[26]

[26] The only item that shows significance is extraversion among the student subject pool, with a coefficient of –4.153, $p = 0.023$.

Taken together, the significant differences in concerns for relative performance between subject pools and within the professionals' pool provide a possible explanation for their rank-dependent behavior in Treatment RANKING. For professionals, relative performance is much more important, and this attitude seems to drive risk-taking when they receive feedback on their ranking.

7 Conclusion and Discussion

In our paper we investigated whether the competition for rank among professionals influences their risk-taking behavior. We ran a framed field experiment with a unique sample of 204 financial professionals from private banking, trading, investment banking, portfolio management, fund management and wealth management.

We find that risk-taking among professionals is strongly rank-driven. First, we show that more risk is taken, on average, when an anonymous and non-incentivized ranking is displayed compared to a baseline setting without rank revelation. Second, we find that underperformers take significantly more risk compared to outperformers to climb up the ranking. The observed effect of rank incentives is remarkable given that we applied the mildest form; subjects only received an anonymous ranking without public disclosure of identities. This approach allowed us to investigate the intrinsic component (i.e., self-image) of rank incentives. Therefore, the observed increase in risk-taking can be attributed solely to professionals' intrinsic desire for outperforming others because extrinsic status concerns would require publicity. Third, we find that incentivizing the ranking monetarily does not change risk-taking in the tournament treatment vis-à-vis the ranking treatment. Fourth, we have replicated the experiment with standard student subjects and find that risk-taking behavior of students is not driven by rankings. Finally, we provide indicative evidence that compared to students, professionals consider it more important to win in social competition. This finding suggests that professionals gain a higher utility from rank incentives, which may explain why professionals take more risk even if the ranking is not payoff relevant.

One possible explanation for the observed rank-driven behavior of professionals is the self-selection of highly competitive individuals into the industry. We have found some indications of this as students of economics and management consider relative performance to be significantly more important than students from other fields of study. Alternatively, the strong focus on relative performance may also be driven by the business culture of the finance industry where rankings, relative performance, and concerns about "being the best" are pervasive features. However, a clean separation of the roles of self-selection and business culture would require a longitudinal study of subjects, probably starting at adolescence. A third and related explanation for rank-dependent behavior may be customer demands. It is well documented for the fund industry (Chevalier and Ellison, 1997; Sirri and Tufano, 1998) that fund inflows are a convex function of past performance, although there is little persistence in fund performance over time (Carhart, 1997; Malkiel, 2003a,b). Hence, achieving a top position by taking more risk could be interpreted as a natural reaction of professionals to the rank orientation of consumer-driven market forces. Which explanation fits best, or contributes most to, the observed rank effect opens up an important avenue for future research. We believe that this study provides a first step by showing that professionals are driven by an intrinsic motivation for positive self-image and therefore compete more and take higher risks as soon as rankings become salient.

The results of this study have important implications. First, from a policy perspective, regulating monetary tournament incentives for professionals might be ineffective as long as rank incentives trigger similar behavior. One option could be to regulate rankings in the profession. However, given the easy accessibility of performance data of financial market participants, this is unlikely to be practical or effective.

Second, from an employer's perspective, it is important to know that rank incentives can substitute for expensive bonuses, provided that increased risk-taking is desirable. This substitution, however, is limited if there is strong competition for talent, leading to excessive pay for top performers (Bénabou and Tirole, 2015). In addition, if increased risk-taking is desirable because, as in our experiment, it increases expected returns, the results of this study will speak in favor of rank incentives. In contrast, if increased risk-taking is not desirable, companies might want to limit or downplay rank incentives. In particular, this may apply to underperformers, because our results show that this group of investors (who are more likely to experience losses) increases risk-taking most strongly. The importance of these implications calls for future research to further disentangle the underlying mechanisms for the distortions in risk-taking due to rankings and their intrinsic and extrinsic components.

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Appendix

Appendix A: Proofs

Proof Proposition 1 Suppose there is information about relative performance. The marginal benefit from the social component adds to the monetary marginal benefit if $\partial v(R_p, s)/\partial R_p > 0$ and $\gamma > 0$, while the marginal costs are not affected. This will shift the solution implicitly defined by (2) toward higher levels of b compared to a situation without information about relative performance. □

Proof Proposition 2 Suppose the assumptions stated in the proposition hold and, additionally, $\frac{\partial^2 v(R_p,s)}{\partial R_p^2} < 0$ over the entire domain. The marginal benefit from the social component is decreasing in R_p and therefore adds less to the private marginal benefit the larger R_p. This implies that the solution to (2) is at a higher level of b the lower the investor's performance. The opposite holds if $\frac{\partial^2 v(R_p,s)}{\partial R_p^2} > 0$ over the entire domain. □

Proof Proposition 3 Suppose there is information about relative performance. The marginal benefit from the social component adds more to the monetary marginal benefit for investor i if $\gamma_i > \gamma_j \geq 0$ and $\partial v_k(R_p, s)/\partial R_p > 0$, with $k = i, j$. This will shift the solution to (2) for investor i toward higher levels of b. □

Appendix B: Additional Figures and Tables

Table A1: Professional subject pool: random effects panel regression with AR(1) disturbance, testing treatment differences of subjects' percentage invested in the risky asset ($RISK$) including Treatment TOURNAMENT (Columns 1 and 2). Random effects panel regression without AR(1) disturbance, testing treatment differences of subjects' percentage invested in the risky asset (Columns 3 and 4).

Dependent variable: $RISK$,	Main regression		Robustness check	
percentage invested in risky asset	(1)	(2)	(3)	(4)
α	89.683***	89.849***	89.549***	89.765***
	(7.629)	(7.653)	(7.569)	(7.493)
$R_{p,t-1}$ (portfolio return)	-0.407***	-0.390***	-0.382***	-0.368***
	(0.064)	(0.050)	(0.112)	(0.079)
$R_{m,t-1}$ (asset return)	-0.136	-0.260***	-0.227**	-0.335***
	(0.109)	(0.088)	(0.110)	(0.124)
RANKING (dummy)	18.874**	19.134**	19.560*	19.644*
	(9.553)	(9.586)	(10.411)	(10.305)
TOURNAMENT (dummy)		23.734**		23.591**
		(9.873)		(11.246)
N	924	1428	924	1428
Clusters	–	–	22	34
R-squared	0.103	0.114	0.103	0.113
$\chi2$	57.765	99.428	36.332	50.366
Prob > $\chi2$	0.000	0.000	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. RANKING (dummy) and TOURNAMENT (dummy) are dummy variables for Treatments RANKING and TOURNAMENT, respectively, with BASELINE as the reference category. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Standard errors are clustered at the group level in the robustness check regressions.

Table A2: Professional subject pool: random effects panel regression without AR(1) disturbance, testing the impact of subject's rank in the previous period $t-1$ ($RANK_{t-1}$) on the percentage invested in the risky asset, $RISK$.

Dependent variable: $RISK$, percentage invested in risky asset	BASELINE	RANKING	TOURNAMENT
α	93.593***	89.981***	87.068***
	(10.640)	(10.785)	(11.301)
$R_{p,t-1}$ (portfolio return)	-0.345***	-0.353**	-0.263**
	(0.129)	(0.144)	(0.106)
$R_{m,t-1}$ (asset return)	-0.292**	-0.224	-0.542**
	(0.131)	(0.154)	(0.266)
$RANK_{t-1}$	-1.174	5.384**	7.613***
	(1.805)	(2.378)	(2.027)
N	336	588	504
Clusters	8	12	14
R-squared	0.095	0.129	0.151
chi2	25.092	19.753	34.798
Prob > $\chi 2$	0.000	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. $RANK_{t-1}$ is subject i's rank in the preceding period. ***, ** and * represent significance at the 1, 5 and 10 percent levels, respectively.

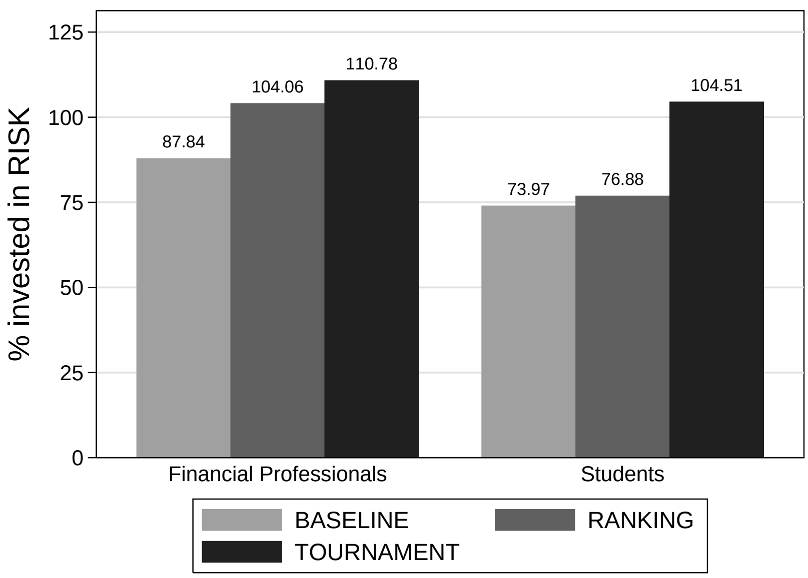

Figure A1: Average fraction invested in the risky asset ($RISK$) across treatments for the financial professionals and the student subject pool.

Table A3: Student subject pool: random effects panel regression with AR(1) disturbance, testing treatment differences of subjects' percentage invested in the risky asset ($RISK$) including Treatment TOURNAMENT (Columns 1 and 2). Random effects panel regression without AR(1) disturbance, testing treatment differences of subjects' percentage invested in the risky asset (Columns 3 and 4).

Dependent variable: $RISK$,	Main regression		Robustness check	
percentage invested in risky asset	(1)	(2)	(3)	(4)
α	73.528***	73.600***	73.314***	73.418***
	(4.301)	(4.303)	(5.013)	(4.985)
$R_{p,t-1}$ (portfolio return)	-0.386***	-0.394***	-0.381***	-0.382***
	(0.047)	(0.040)	(0.077)	(0.063)
$R_{m,t-1}$ (asset return)	-0.041	-0.056	-0.079	-0.116*
	(0.060)	(0.057)	(0.062)	(0.065)
RANKING (dummy)	5.854	5.888	6.352	6.406
	(6.089)	(6.089)	(7.058)	(7.055)
TOURNAMENT (dummy)		33.069***		32.774***
		(6.081)		(7.326)
N	2016	3024	2016	3024
Clusters	–	–	48	72
R-squared	0.072	0.097	0.071	0.097
chi2	83.290	153.791	34.114	78.641
Prob > $\chi2$	0.000	0.000	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. RANKING (dummy) and TOURNAMENT (dummy) are dummy variables for Treatments RANKING and TOURNAMENT, respectively, with BASELINE as the reference category. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Standard errors are clustered at the group level in the robustness check regressions.

Table A4: Student subject pool: random effects panel regression without AR(1) disturbance, testing the impact of subject's rank in the previous period $t-1$ ($RANK_{t-1}$) on the percentage invested in the risky asset, $RISK$.

Dependent variable: $RISK$, percentage invested in risky asset	BASELINE	RANKING	TOURNAMENT
α	70.200***	71.625***	72.372***
	(9.370)	(7.613)	(10.493)
$R_{p,t-1}$ (portfolio return)	-0.419***	-0.280***	-0.209*
	(0.111)	(0.106)	(0.109)
$R_{m,t-1}$ (asset return)	-0.073	-0.129*	-0.318*
	(0.091)	(0.074)	(0.177)
$RANK_{t-1}$	0.877	2.122	9.737***
	(1.791)	(1.436)	(2.155)
N	1008	1008	1008
Clusters	24	24	24
R-squared	0.096	0.049	0.079
chi2	32.220	17.977	66.224
Prob > $\chi 2$	0.000	0.000	0.000

Notes: $R_{p,t-1}$ is the log-return of subject i's portfolio since the start of the experiment and $R_{m,t-1}$ is the preceding period's asset return. $RANK_{t-1}$ is subject i's rank in the preceding period. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively.

Table A5: Ordinary least squares regression of subjects' average amount invested in the risky asset, $\overline{RISK}$.

Dependent variable: $\overline{RISK}$,	Professional sample			Student sample		
mean percentage invested in risky asset	(1)	(2)	(3)	(4)	(5)	(6)
α	47.628**	57.405	5.937	21.236**	32.544**	32.004
	(18.706)	(33.711)	(83.669)	(9.099)	(15.080)	(51.673)
$SOCIAL\_STATUS$	-4.391	-3.785	-4.013	-1.298	-2.993	-1.653
	(2.781)	(3.996)	(3.993)	(1.695)	(2.362)	(2.732)
$FINANCIAL\_SUCCESS$	0.615	2.408	2.150	0.814	0.542	1.027
	(2.402)	(3.701)	(4.395)	(1.483)	(2.601)	(2.751)
$LOSS\_TOLERANCE$	37.524**	34.386	30.505	50.328***	51.542***	51.493***
	(17.080)	(26.706)	(26.401)	(15.866)	(16.963)	(17.461)
$GENERAL\_RISK$	12.227***	9.965**	11.078***	12.454***	13.987***	14.444***
	(2.001)	(3.426)	(3.618)	(1.586)	(1.669)	(1.983)
CRT_SCORE			8.607			2.227
			(6.357)			(4.060)
$BIG-5$	no	no	yes	no	no	yes
$DARK\_TRIAD$	no	no	yes	no	no	yes
N	204	102	102	432	192	192
Cluster	34	17	17	72	32	32
R-squared	0.177	0.114	0.191	0.184	0.226	0.269
F	18.735	3.797	3.570	21.959	33.181	13.680
Prob > F	0.000	0.023	0.009	0.000	0.000	0.000

Notes: Model 1 (Model 4) is the total sample, Model 2 (Model 5) the sub-sample with non-missing Q3, and Model 3 (Model 6) controls additionally for CRT_SCORE, $BIG-5$ and $DARK\_TRIAD$. $SOCIAL\_STATUS$ and $FINANCIAL\_SUCCESS$ represent the answers to corresponding survey questions on a 7-point Likert scale (higher values indicate stronger preferences). $LOSS\_TOLERANCE$ is a measure of loss attitudes (from 0 to 1; higher values indicate lower loss aversion) and $GENERAL\_RISK$ is the self-reported willingness to take risks (7-point Likert scale).[a] ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Standard errors are clustered at the group level.

[a]The only item which shows significance is extraversion, with a coefficient of –4.135, $p = 0.024$.

Appendix C: Instructions of the Experiment[27]

Welcome to the experiment and thank you for your participation!

Please do not talk with the other participants during the experiment from now on.

General Information

In this experiment we study economic decision-making. The whole experiment consists of two independent parts, where you can earn money independently. For your punctual attendance and participation you will receive a participation fee of 18 euro in addition to the income you can earn in both parts of the experiment. Your entire payment will be paid out to you privately and in cash after the experiment. At the beginning of each part you will receive detailed instructions. If you have questions about the instructions or during the experiment, please raise your hand. One of the experimenters will then come to you and answer your questions privately.

PART 1

Task

In Part 1 you have to make investment decisions in a financial market. At the beginning of the experiment, you start with a wealth of 90 euro. You have to decide in each of eight periods (half-years), what percentage of your wealth you want to invest at a risk-free rate of 1.5% and the percentage you wish to invest in a stock index. The development of the stock index reflects the price development of a basket of shares and is based on actual historical data. In the last 20 years, this development is characterized by price fluctuations. In this period, the index earned a half-year return (semi-annual compounding) of 3.6% and had a standard deviation of the semi-annual price returns of 15.9%.

Here are some examples on the likelihood of various price fluctuations:

In 50 out of 100 cases, the semi-annual return lies between -7.1% and 14.3%.

In 90 out of 100 cases, the semi-annual return lies between -22.6% and 29.8%.

In 95 out of 100 cases, the semi-annual return lies between -27.6% and 34.7%.

At the beginning of the first period, you have to draw 30 times from this distribution (at your laptop) with a mean of 3.6% and a standard deviation of 15.9%. The draws are independent for each participant. After each draw the last drawn return is indicated on the screen with a yellow box together with the display of return (see Figure A2).

The previous return draws are shown with red boxes. Every time you click on the "Draw return" button, a new return is drawn from the distribution and displayed on the screen. Together, the draws give you a feeling for the index changes from period to period. The draws are independent of the random draws during the experiment, but the distribution is identical. Below you see an example of the screen (see Figure A2):

[27] Instructions are for Treatment BASELINE, additional text for Treatments RANKING and

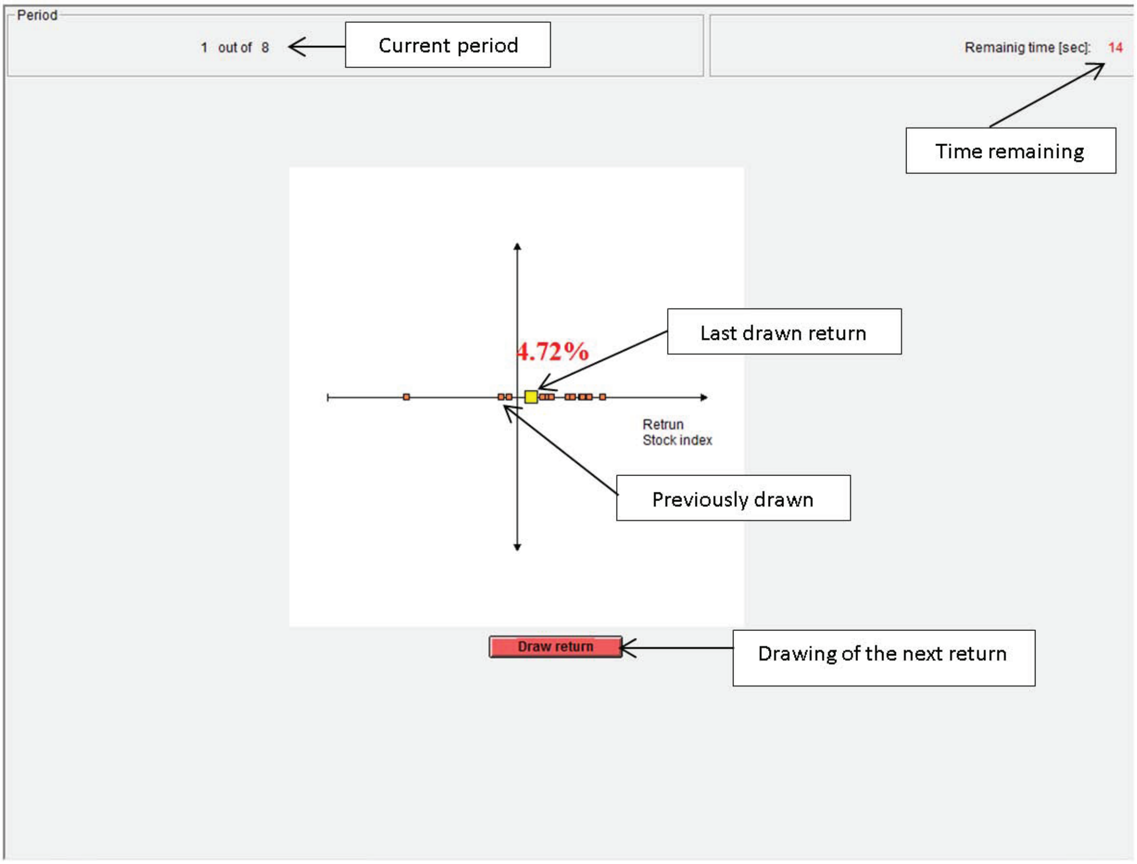

Figure A2: Return screen in Period 1.

In each period you can invest between 0 and 200% of your current wealth in the stock index. If you invest more than 100% of your wealth, then the fraction which exceeds 100% is borrowed at the risk-free rate of 1.5%. If you are investing less than 100% of your wealth in the stock index, the amount not invested in the stock index is invested at the risk-free rate of 1.5%. You will be selected into a group of 6 participants at the beginning of the experiment and you will remain in the same group for the duration of the experiment (8 periods). At the end of each period the actual return of the stock index is randomly determined from the distribution described above and your wealth will be calculated according to your investment in the stock index and in the risk-free rate. Note that the stock index return is identical for all group members.

TOURNAMENT are in *italic*. The relevant parts on the payout in Treatment TOURNAMENT are in `teletype`.

Examples:

1. Let's assume your wealth is 90 euro and you decide to invest 50% of it in the stock index. Thus, the remaining 50% will be invested at the risk-free rate. If the index in this period yields a return of + 10.0%, then your wealth in the next period will be as follows: Profit/loss from the stock index: (50% Investment * 90 euro) * 10% Return = 4.5 euro. Profit from investing in the risk-free interest rate: (50% Investment * 90 euro) * 1.5% Interest = 0.68 euro. Wealth in the next period: 90 (previous periods wealth) + 4.5 + 0.68 = 95.18 euro.

2. Let's assume your wealth is 90 euro and you decide to invest 150% of it in the stock index. Thus, you borrow 50% at the risk-free interest rate. If the index in this period yields a return of + 10.0%, then your wealth in the next period will be as follows: Profit/loss from the stock index: (150% Investment * 90 euro) * 10% Return = 13.5 euro. Cost of borrowing 50% at the risk-free rate: (-50% Loan * 90 euro) * 1.5% Interest = -0.68 euro. Wealth in the next period: 90 (previous periods wealth) + 13.5 - 0.68 = 102.82 euro.

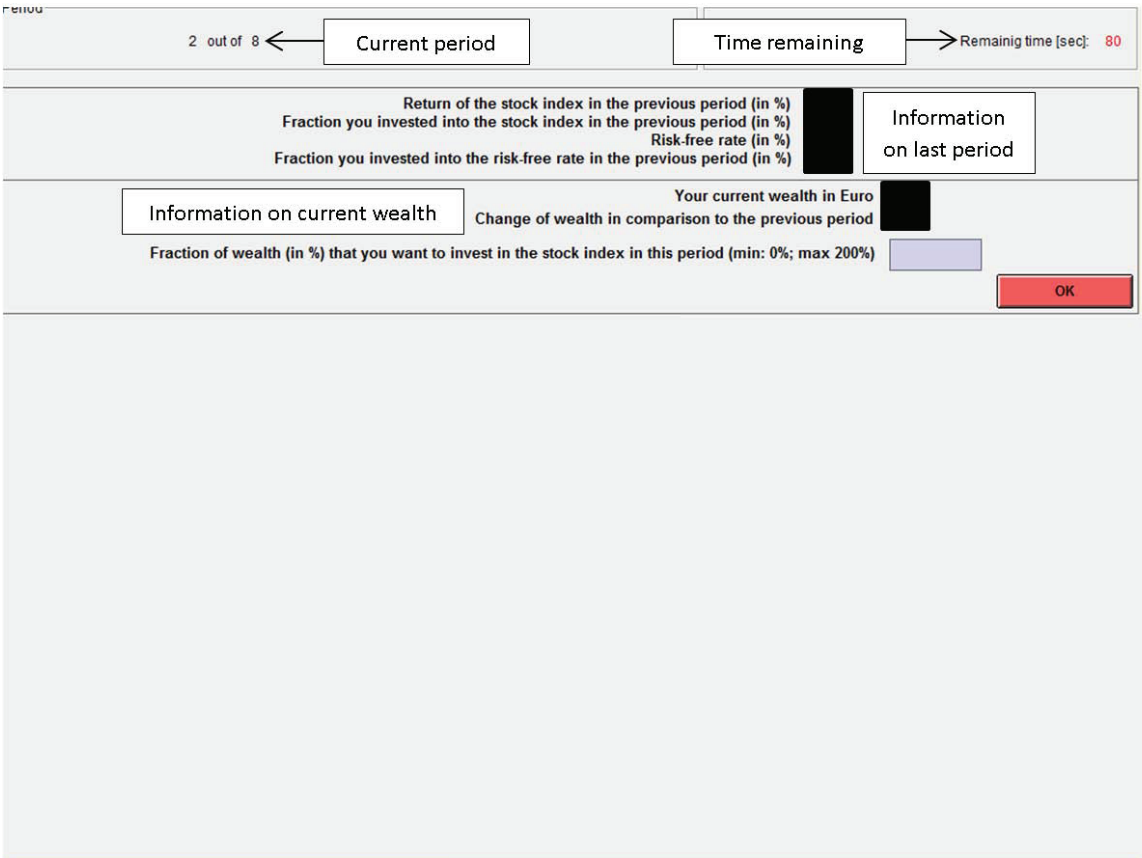

Figure A3: Decision screen in each period (note that this screen is only shown in Treatment BASELINE).

The decision screen in each period will show your current wealth, the wealth change compared to the previous period, the return of the stock index in the previous period, your invested fraction in the stock index in the previous period, the risk-free rate and your invested fraction in the risk-free asset in the previous period (see Figure A3).[28]

The decision screen in all 8 periods looks as follows:

[28]See Figure A4 for Treatments RANKING and TOURNAMENT.

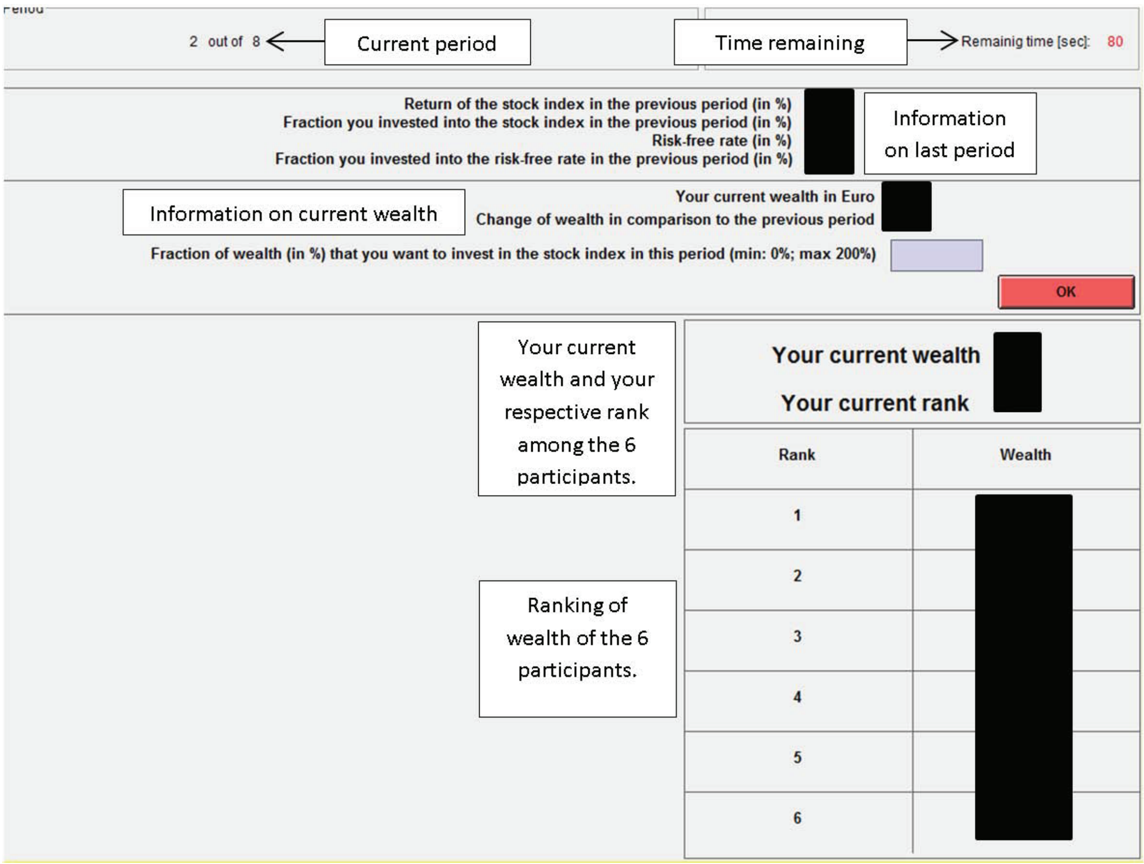

Figure A4: Decision screen in each period (note that this screen is only shown in Treatments RANKING; TOURNAMENT).

[Begin additional text for Treatments RANKING and TOURNAMENT]

Beginning with Period 2, you will be informed in a league table which rank in your group of 6 you currently have based on the current wealth of the participants. You also get information about the current wealth and rank of the other participants in your group. This table appears for 20 seconds at the beginning of each period (see Figure A5) and is also displayed at the bottom of the decision screen (see Figure A4).

[End additional text for Treatments RANKING and TOURNAMENT]

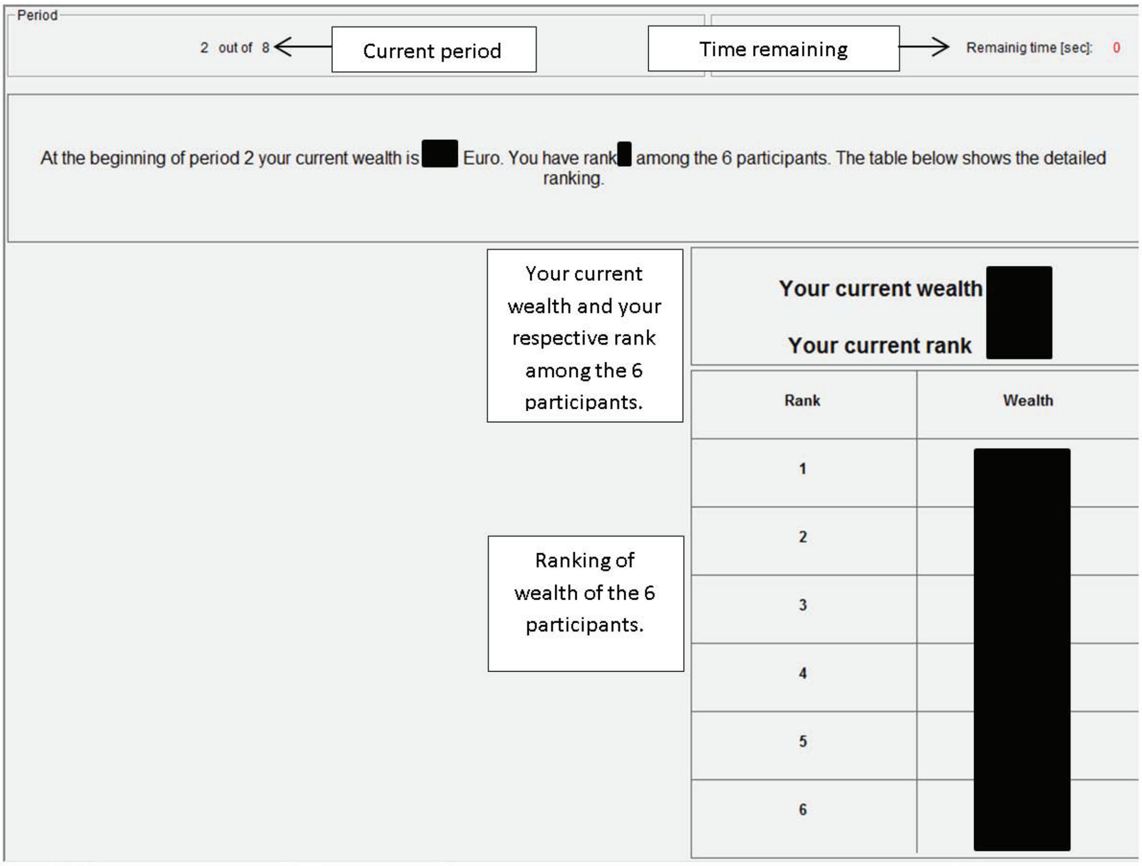

Figure A5: Screen on your ranking and the current wealth of the other participants at the beginning of each period. This table is shown from period 2 onward (note that this screen is only shown in Treatments RANKING; TOURNAMENT).

Payment

[Begin text for Treatments BASELINE and RANKING]

At the end of the experiment, your final wealth (your wealth at the end of period 8) will be paid out to you with a probability of 20%. A random generator determines for each participant separately whether he or she receives the payment. If you are not drawn randomly, you will not receive payment for the first part of the experiment.

[End text for Treatments BASELINE and RANKING]

[Begin text for Treatment TOURNAMENT]

At the end of the experiment the wealth of all 6 participants in your group will be summed up and distributed according to your ranking as follows: the participant with rank 1 receives 50%, rank 2 receives 33.3%, rank 3 receives 16.7%, and the ranks 4, 5, and 6 receive 0%. Your calculated final wealth will be paid out with a probability of 20%. A random generator determines for each participant separately whether he `or she receives the payment. If you are not drawn randomly, you will not receive payment for the first part of the experiment.`

[End text for Treatment TOURNAMENT]

PART 2

Below are the instructions for Part 2 of this experiment.

Remember: You get 18 euro for participating in this experiment. In Part 2, you can earn (and lose) in addition to this participation fee. Part 1 and Part 2 are independent in the decisions and in payment.

Part 2 consists of two sections that are played one after the other. For each of the two sections, your potential payment will be calculated individually and independently. At the end of Part 2 one of the two sections will be randomly selected for your payment for Part 2 (for details on payment, see below).

Section 1

In Section 1, you are asked to make 7 decisions (decision pairs). For each decision pair, you have the choice between Option A and Option B:

OPTION A: A payment with 100% probability (certainty) is realized. This option is available in all seven decision pairs.

OPTION B: A payment that is risky – either 0 euro with 50% probability or 24 euro with 50% probability.

For your payment, ONE out of the 7 decision pairs will be randomly selected and used for payment according to your decision.

Section 2

In the 6 questions of Section 2 you have to decide whether you want to participate in a lottery where you can win or lose money. If you choose the lottery, the computer flips a coin. If the coin shows heads, you get 15 euro in addition to your participation fee. If the coin shows tails, you lose a certain amount of your participation fee. If you do not choose the lottery, you will receive 0 euro in addition to your participation fees.

For your payment, ONE out of the 6 decision pairs will be randomly selected and used for payment according to your decision.

In Part 2, one of the two sections will be randomly selected and paid out at the end of the experiment; in addition to the participation fee and in addition to the payment of Part 1. Please note: In Part 2, next to playing out a possible lottery, there is a maximum of two random drawings. The first random draw is used to select which section is relevant for your payment. In a second step, one of the decision pairs will be randomly chosen from the relevant section. Your decision (lottery or fixed payment) is then played out to determine your payment.

Questionnaire

Following Part 2 you will be asked to answer some general questions and provide us with some anonymous demographic details.

Thank you for your participation!

Appendix D: Pictures of the Experimental Laboratories

Figure A6: Top: Example of a mobile laboratory in the conference room of a financial institution. Bottom: Innsbruck EconLab.

Appendix E: Modified CRT Questions

- An IT company offers you storage space. Every day your volume of data doubles. If it would need 20 days to max out the provided space, how long would it take to max out half of the space?
- A football shoe and a ball cost 110 euro together. The shoe costs 70 euro more than the ball. How much costs the ball?
- 5 machines need 5 minutes to produce 5 keyboards. How long would 80 machines need for 80 keyboards?