

"Crisis can bring out the best in a company and its people. Rather than yield to pessimism, our organization has moved forward with a renewed sense of purpose to succeed. Through hard work and tough choices, we made significant progress during the past 365 days." (Sergio Marchionne, CEO Chrysler Group LLC, The Wall Street Journal, 2010)

1 Introduction

Corporate careers are very important for individuals since they are accompanied by social relations, the acquisition of seniority rights, the accumulation of firm-specific human capital and future expected incomes. Employees' careers are seriously threatened if a firm gets into trouble or even files for bankruptcy. In this case, many employees lose their jobs¹ or must accept substantial wage cuts. For example, in 2009 General Motors Corp reduced its workforce from 73,000 to 63,000 and imposed wage cuts on most white-collar workers in the U.S. ranging from 3% to 10%. Similarly, Chrysler LLC dismissed more than 8,000 workers in 2008 while Toyota cut pay and output in two British factories by 10% in 2009 to deal with recession. Hamermesh (1989) reports that in the 1980s one-half million US-workers have become unemployed due to plant closings and that the average loss of earnings was substantial. The event of a firm bankruptcy does not only depend on exogenous factors but also on the employees' endogenous effort choices. Employees choose efforts both as a response to short-term incentive schemes (e.g., bonuses) and as an investment in their long-term careers (Rosen, 1986). As these investments may be lost in case of a bankruptcy, it is important to investigate whether the shadow of bankruptcy leads to higher or lower incentives.

There are two possible answers. On the one hand, incentives may be boosted considerably because employees are highly interested in protecting their jobs and, hence, the investments in their corporate careers. As a consequence, the possibility of firm bankruptcy should result into significantly extra incentives compared to a situation where careers are secure. On the other hand, under possible firm bankruptcy employees will realize future career incomes only with a certain probability, which should reduce work incentives. Moreover, since the survival of the firm depends on the efforts of many employees and other stakeholders, each employee faces a typical free-rider problem, which should further lead to effort reduction. In this paper, we analyze the incentive effects of possible firm bankruptcy both theoretically and experimentally. A theoretical analysis is necessary to find out which of the conflicting effects is crucial for the employees when deciding on efforts. An experimental investigation can address behavioral effects, which may arise from the importance of a job loss. Of course, the loss of social relations

¹Helliwell (2003) reports that the decrease in happiness when losing a job is equal to a significant drop in health and even larger than the decrease of happiness at the death of a spouse.

and accumulated human capital cannot be analyzed in the laboratory, but we can test whether the possibility of a complete loss of payoffs leads to behavioral patterns that are not covered by our theoretical model.

Following the seminal papers by Lazear and Rosen (1981), Green and Stokey (1983), Nalebuff and Stiglitz (1983), and O’Keeffe et al. (1984), we model employees’ corporate careers as a rank-order tournament: In a stylized situation with one vacant position on a higher hierarchy level and two competing employees, the better performing employee will be promoted and realize an income increase, whereas the tournament loser stays at his current job. However, if the firm goes bankrupt, both the tournament winner and the tournament loser will lose their incomes. Our theoretical results show that the incentive effect of possible firm bankruptcy crucially depends on whether employees’ efforts are strategic substitutes or strategic complements in the sense of Bulow et al. (1985). In case of low bankruptcy risk, efforts are strategic substitutes so that more aggressive behavior by one employee decreases the activity level of his opponent. Since each employee wants to make use of this strategic effect, in equilibrium both end up in a situation with higher effort levels compared to the benchmark case without bankruptcy. However, if employees face a high bankruptcy risk, tournament efforts will be strategic complements. Now, less effort by one of the employees induces less effort by the other worker. Consequently, both players use this effect and behave less aggressively than in the benchmark case without bankruptcy. In this situation, the employees must succeed as a team in order to guarantee survival of the firm. As is known in the literature, teamwork suffers from free riding, which also appears in the given context.

In the experiment, we consider a winner-take-all situation with a positive winner prize and a zero loser prize (i.e., the current income of the two employees is normalized to zero so that the winner prize covers the full income increase following promotion). Our experimental findings are qualitatively in line with Nash equilibrium behavior: On average, individuals chose highest effort under low bankruptcy risk, but they chose higher effort in the standard tournament without firm bankruptcy than in the tournament with high bankruptcy risk. However, in either setting – low, no and high risk of bankruptcy – subjects invested significantly more effort than theoretically predicted. While this observation is not unusual for experiments on tournaments, excessive effort supply under high bankruptcy risk remains a puzzle. In that setting, average effort is more than twice as high compared to the equilibrium effort level. The doubled amount of effort has a strong implication for the firm’s survival probability, which becomes five times higher than in equilibrium. We conjecture that subjects realize an additional disutility from the shadow of bankruptcy, which increases in both the career incomes at risk and the bankruptcy probability, and that subjects chose higher efforts to decrease this disutility. Supplementing the basic tournament model by a disutility-of-bankruptcy function can explain the very large deviation from equilibrium effort under high bankruptcy risk. In

order to test the new theoretical setting, we introduced positive loser prizes under a low risk of bankruptcy. The experimental results strictly contradict the basic tournament model without disutility-of-bankruptcy function, but are quite in line with the extended model.

The experimental results have two important implications for the personnel policy of a firm: First, in bad economic situations in which a firm has a positive likelihood of going bankrupt, employees will rather struggle to guarantee survival of the firm than to give up or free ride. Hence, the management should not be afraid that an initially small crisis or even the rumor on a possible crisis will end up in the firm going bankrupt. On the contrary, it seems realistic that if a firm faces a difficult situation, this crisis will make the employees stick together and supply additional efforts to protect their corporate careers.

Second, top management can strategically use debt in order to boost employees' incentives. Our experimental and theoretical results point out that moderate financial leverage leading to low bankruptcy risk yields additional incentives compared to a situation with zero bankruptcy risk. Hence, borrowing may be useful to finance profitable investments, but even additional debt for investments with a negative net present value can be beneficial if the additional incentive effects are sufficiently large. Of course, additional debt may also enhance work incentives under alternative incentives schemes like bonuses. However, under these systems incentives can be raised without additional costs by appropriately adjusting the quota that is imposed on the employee instead of increasing debt. Moreover, bonus systems require verifiable performance signals whereas tournaments even work under subjective performance evaluation due to the self-commitment property of the tournament prizes, which are fixed in advance (Malcomson, 1984, 1986). Finally, the extra tournament incentives under low bankruptcy risk are based on the employees' interaction and the fact that efforts are strategic substitutes. Under a bonus scheme, however, such effects do not exist since employees are compensated independently.

Our paper is related to the work on incentive effects of bankruptcy. This topic has been addressed by papers in financial economics as well as by labor economists. Contributions to financial economics focus on the incentive effects of a firm's capital structure on management behavior. Grossman and Hart (1982) and Hart (1995) point out that issuing debt and, thereby, generating a positive probability of bankruptcy can be a powerful instrument to discipline managers. Since bankruptcy is accompanied by the loss of their jobs, managers have strong incentives to exert high effort and make profitable investments. Jensen (1986) argues that debt is effective in preventing managers from investing free cash flow into projects that are not profitable from the shareholders' perspective. Schmidt (1997) analyzes the disciplining of managers via firm liquidation without explicitly addressing the role of debt. He shows that increased market competition reduces a firm's profits but improves managerial incentives as the likelihood of firm liquidation goes up. Berkovitch et al. (2000) combine managerial compensation with the choice of

the firm's capital structure. By introducing risky debt, the shareholders credibly commit to frequent replacement of the chief executive officer (CEO) in case of poor firm performance, which enhances CEO motivation. Dewatripont and Tirole (1994) as well as Berkovitch and Israel (1996) also discuss the combination of CEO compensation and a firm's capital structure as a disciplining device. They particularly address the optimal allocation of control rights within an incomplete-contracting framework. Povel and Raith (2004) stress the disciplining role of debt for an entrepreneur in a setting where investments and revenues are unobservable to outsiders.

Several papers combine financial and labor economic issues by analyzing optimal incentives for managers who are primarily responsible for the personnel policy of the firm. Garvey and Swan (1992a) analyze the capital structure of a firm with several hierarchical levels. Moderate debt and the corresponding risk of bankruptcy disciplines the firm's CEO to choose optimal bonuses for the divisional managers. The optimal debt-equity ratio decreases in the number of hierarchy levels and the influence of lower hierarchical tiers on firm performance. In their companion paper, Garvey and Swan (1992b) apply their incentive scheme to a CEO who has to design tournament incentives for workers. Given unverifiable worker performance, tournaments avoid opportunistic behavior by the firm's owner who credibly commits himself to pay out the promised tournament prizes. However, tournaments may foster sabotage and eliminate efficient cooperation (e.g., mutual help). To get rid of this problem, Garvey and Swan suggest to discipline the CEO – who dislikes pay inequality – by issuing debt leading to a positive probability of the firm going bankrupt and the CEO losing her job. In the paper by Gaston (1997) the CEO has full discretion of paying efficiency wages to the workers of the firm. Disciplining by debt and the risk of bankruptcy makes the CEO choose a compensation policy that is optimal from the viewpoint of the shareholders.

Part of the literature on labor economics discusses the possibility of firm bankruptcy and its incentive implications on workers instead of managers. Three papers are based on tournament models.² Berkowitz and Kotowitz (1993) consider professional partnerships where associates are compensated by relative piece rates or compete in tournaments either for monetary prizes or for promotion to become partner. Their setting includes team production and double moral hazard (by both associates and partners). Since partners are financially constrained, which implies the possibility of the partnership's bankruptcy, the optimal incentive scheme is a promotion-to-partner tournament in order to let the tournament winner participate in the residual claim and, hence, to reduce the risk of bankruptcy. Zbojník and Bernhardt (2001) discuss corporate tournaments in heterogeneous firms that differ in productivity and belong to the same competitive

²Of course, there are many theoretical and empirical papers that discuss the impact of bankruptcy on the firm's compensation policy, but do not refer to tournaments. See, for example, Curme and Kahn (1990) on the influence of bankruptcy on deferred compensation.

market. Tournament prizes are endogenously determined by competition for workers in the labor market. Workers' acquired human capital is not observable by other employers, but promotion to a better job serves as a signal. Introducing an exogenous probability of firm bankruptcy in this setting leads to a positive correlation between a firm's size and productivity on the one hand and workers' labor market experience on the other hand. Friebel and Matros (2005) show that workers exert less effort under high bankruptcy risk compared to a situation with less risk of bankruptcy. Workers are assumed to compete along their career paths for promotion to better paid jobs at higher hierarchy levels. Since the risk of firm bankruptcy is assumed to be completely exogenous, a higher risk of bankruptcy solely implies a lower expected prize from winning the job-promotion tournament, which decreases incentives. As a second result, Friebel and Matros show that promoted workers in firms with higher bankruptcy risk earn higher wages. This result is due to the assumption of competitive markets, which force more risky firms to pay higher wages on higher levels in order to be attractive for workers. In our paper, we also consider tournament incentives for workers in a corporate hierarchy with firm bankruptcy but let the probability of bankruptcy be endogenously determined by workers' effort choices. Moreover, we ran a laboratory experiment to test our theoretical results and to investigate the behavior of real decision makers that face a risky career system.

Finally, our paper is related to experimental papers on tournaments that document an oversupply of effort compared to the Nash equilibrium level. Bull et al. (1987) conducted one of the first experiments on tournaments. They found that average efforts converged to the equilibrium levels during the whole length of 12 rounds. However, in single rounds subjects chose more effort than theoretically predicted. Weigelt et al. (1989) ran tournament treatments between both symmetric and asymmetric contestants. In all treatments, average efforts exceeded theoretically predicted ones. Similar findings were made by Schotter and Weigelt (1992) who also documented higher average efforts compared to equilibrium levels in both symmetric and asymmetric matches. Orrison et al. (2004) analyzed subjects' behavior in 2-person, 4-person and 6-person tournaments. For the asymmetric 2-person matches they found a clear oversupply of effort. The results of Harbring and Lünser (2008) refer to three symmetric and three asymmetric treatments. While average efforts were higher than theoretically predicted in five of the six treatments, a significant difference only holds for the asymmetric treatment with the biggest prize spread. Harbring and Irlenbusch (2005) and Harbring et al. (2007) introduced the possibility of sabotage and found that subjects nevertheless chose excessively high efforts. Oversupply of effort is also documented from the recent tournament experiment by Eriksson et al. (2009). Altogether, significantly larger effort levels of subjects in tournament experiments are not unusual at all. Hence, the really puzzling part of our experimental findings is the very large effort level and the corresponding survival probability found in our treatment with high bankruptcy risk.

The remainder of the paper is organized as follows. The next section introduces the basic tournament model with low, no and high risk of bankruptcy. Section 3 presents the equilibrium efforts for the three settings. Sections 4 and 5 contain the description of the experiment and our hypotheses. In Section 6, we document our experimental results. Section 7 discusses the puzzling observations on high bankruptcy risk and alternative theoretical approaches, which may better explain our experimental findings than the basic model of Section 2. Section 8 concludes.

2 The Basic Model

We consider the internal careers of two workers 1 and 2. In the current situation, each worker i ($i = 1, 2$) receives a monetary income $w_L \geq 0$. One of the workers will be promoted to a higher level of the corporate hierarchy. This higher position is associated with income $w_H > w_L$. The promotion decision is based on relative performance: If worker i produces higher output than worker j ($i, j = 1, 2; i \neq j$) he will be promoted to the higher position with income w_H , whereas the other worker will stay at his current position with income w_L . If both workers produce equal output, the winner of the job-promotion tournament will be determined by the toss of a fair coin. The workers use a stochastic production technology. With probability $p(a_i) \in [0, 1]$ player i realizes high output $\pi_i = \pi_H$ in monetary terms and with probability $1 - p(a_i)$ the player only realizes $\pi_i = \pi_L$ with $\pi_L \in (0, \pi_H)$. Here, $a_i \geq 0$ denotes worker i 's activity or effort level. We assume that $p(a_i)$ is monotonically increasing and concave, being strictly smaller than one in equilibrium, and $p(0) = 0$.

Effort entails costs to a worker which are described by the function $c(a_i)$. We assume that $c'(a_i) > 0$, $c''(a_i) < 0$, $\forall a_i > 0$, and $c(0) = c'(0) = 0$. In order to guarantee that workers' efficient effort levels always increase in the high output π_H , we impose the additional restriction

$$\frac{d}{da_i} \left(\frac{c'(a_i)}{p'(a_i)p(a_i)} \right) > 0, \forall a_i > 0, \quad (1)$$

which is satisfied for $c(a_i) = \frac{c}{3}a_i^3$ ($c > 0$) and $p(a_i) = a_i \in [0, 1]$, for example.

Our paper departs from the standard tournament literature by introducing the possibility of firm bankruptcy. Such event typically leads to a utility loss of the firm's workforce since there are mass layoffs, wage cuts and cuts in pension plans, for example. In the following, we reduce the negative implications of bankruptcy to the loss of both workers' career incomes, which happens if firm performance is not sufficiently good. In particular, both workers will earn future incomes w_L and w_H only if $\pi_1 + \pi_2 \geq \bar{\Pi}$ with $\bar{\Pi} > 0$ as the minimum firm profit that is necessary to prevent bankruptcy. In case of $\pi_1 + \pi_2 < \bar{\Pi}$, the firm goes bankrupt and the two workers lose their future incomes. We have to differentiate between three cases: (1) if $\bar{\Pi} \in [0, 2\pi_L]$, the threshold for firm per-

formance is so low that the firm can never become bankrupt. This case is identical to a standard job-promotion tournament without bankruptcy. (2) When $\bar{\Pi} \in (2\pi_L, \pi_L + \pi_H]$, the survival of the firm and, hence, career incomes are guaranteed if at least one of the workers has realized the high output level. (3) When $\bar{\Pi} \in (\pi_L + \pi_H, 2\pi_H]$, the workers will earn their incomes w_L and w_H only if both have realized a high output level.

The timing of the game is as follows. First, the workers observe all parameters of the game, especially the threshold $\bar{\Pi}$ and future career incomes w_L and w_H . Then, they simultaneously choose efforts a_1 and a_2 . Finally, outputs π_1 and π_2 are realized, and the workers obtain either their career incomes or – in case of bankruptcy – zero.

3 Solution to the Basic Model

When solving the workers' problem, we have again to differentiate between the three cases for the threshold value $\bar{\Pi}$. In the setting with $\bar{\Pi} \in [0, 2\pi_L]$ there is *no* risk of bankruptcy. Worker i maximizes

$$\begin{aligned} EU_i(a_i) &= w_H p(a_i) (1 - p(a_j)) + \frac{w_H + w_L}{2} [p(a_i) p(a_j) + (1 - p(a_i)) (1 - p(a_j))] \\ &\quad + (1 - p(a_i)) p(a_j) w_L - c(a_i) \\ &= \frac{1}{2} (w_H + w_L) + \frac{1}{2} p(a_i) (w_H - w_L) - \frac{1}{2} p(a_j) (w_H - w_L) - c(a_i). \end{aligned} \quad (2)$$

The first-order condition shows that each worker has a dominant strategy a_{no}^* .³

$$\frac{1}{2} (w_H - w_L) p'(a_{no}^*) - c'(a_{no}^*) = 0 \Leftrightarrow \frac{1}{2} (w_H - w_L) = h(a_{no}^*) \quad (3)$$

with $h(a) := c'(a) / p'(a)$ being monotonically increasing. As typical for the standard-tournament case, equilibrium efforts increase in the prize spread $w_H - w_L$ (i.e., decrease in the loser prize w_L as a kind of fall-back position, and increase in the winner prize w_H).

In case of *low* bankruptcy risk (i.e., $\bar{\Pi} \in (2\pi_L, \pi_L + \pi_H]$), worker i 's strictly concave objective function is given by

$$EU_i(a_i) = w_H p(a_i) (1 - p(a_j)) + \frac{w_H + w_L}{2} p(a_i) p(a_j) + w_L p(a_j) (1 - p(a_i)) - c(a_i). \quad (4)$$

The first-order condition $EU'_i(a_i) = 0$ can be rewritten as

$$w_H - \frac{w_H + w_L}{2} p(a_j) = h(a_i). \quad (5)$$

In analogy, we obtain

$$w_H - \frac{w_H + w_L}{2} p(a_i) = h(a_j) \quad (6)$$

³The subscript "no" indicates that the setting without risk of bankruptcy is considered.

from worker j 's first-order condition. The two reaction functions (5) and (6) show that we have a unique and symmetric equilibrium $(a_1^*, a_2^*) = (a_{low}^*, a_{low}^*)$ implicitly described by⁴

$$w_H - \frac{w_H + w_L}{2} p(a_{low}^*) = h(a_{low}^*). \quad (7)$$

Implicit differentiation of (7) shows that – as in the standard-tournament case – again equilibrium efforts decrease in the loser prize w_L and increase in the winner prize w_H :

$$\begin{aligned} \frac{\partial a_{low}^*}{\partial w_L} &= \frac{-\frac{1}{2} p'(a_{low}^*)}{\frac{w_H + w_L}{2} p'(a_{low}^*) + h'(a_{low}^*)} < 0 \\ \frac{\partial a_{low}^*}{\partial w_H} &= \frac{1 - \frac{1}{2} p'(a_{low}^*)}{\frac{w_H + w_L}{2} p'(a_{low}^*) + h'(a_{low}^*)} > 0. \end{aligned}$$

Finally, we have to solve for the equilibrium in the case with *high* bankruptcy risk (i.e., $\bar{\Pi} \in (\pi_L + \pi_H, 2\pi_H]$). Here, each worker i maximizes the strictly concave function

$$EU_i(a_i) = \frac{w_H + w_L}{2} p(a_i) p(a_j) - c(a_i). \quad (8)$$

The first-order condition yields

$$\frac{w_H + w_L}{2} p(a_j) p'(a_i) = c'(a_i). \quad (9)$$

Analogously, the first-order condition for worker j gives

$$\frac{w_H + w_L}{2} p(a_i) p'(a_j) = c'(a_j). \quad (10)$$

Obviously, there is one symmetric equilibrium where each worker exerts zero effort. Intuitively, if one worker chooses zero effort, his probability of realizing the high output will be $p(0) = 0$. In this situation, the other worker has not any chance to prevent bankruptcy. The best he can do is minimizing effort costs by choosing zero effort as well.

Using again the definition $h(a) := c'(a)/p'(a)$ when combining (9) and (10) leads to

$$\frac{w_H + w_L}{2} = \frac{h(a_i)}{p(a_j)} = \frac{h(a_j)}{p(a_i)} \Leftrightarrow h(a_i) p(a_i) = h(a_j) p(a_j).$$

Since both sides of the last equation describe the same monotonically increasing function of a_i and a_j , respectively, we have a second symmetric equilibrium where each worker exerts effort a_{high}^* characterized by⁵

$$\frac{w_H + w_L}{2} p(a_{high}^*) = h(a_{high}^*). \quad (11)$$

⁴The subscript "low" points to the low risk of bankruptcy in this scenario with $\bar{\Pi} \in (2\pi_L, \pi_L + \pi_H]$.

⁵The subscript "high" stands for high bankruptcy risk.

In this scenario, equilibrium effort a_{high}^* increases in both the winner prize w_H and the loser prize w_L .⁶ Note that from the workers' point of view the equilibrium (a_{high}^*, a_{high}^*) Pareto dominates the equilibrium where both choose zero efforts. Thus, (a_{high}^*, a_{high}^*) seems to be the more plausible outcome of the game. By applying Pareto dominance as Nash refinement we exclude the zero-effort equilibrium in the following.⁷

Comparing equilibrium efforts leads to the following result:⁸

Proposition 1 *If w_L is sufficiently small, equilibrium efforts under the risk of bankruptcy follow the ranking $a_{low}^* > a_{no}^* > a_{high}^*$. In any case, we have $a_{low}^* > a_{no}^*$.*

Proof. First, compare a_{no}^* with a_{low}^* described by (3) and (7), respectively. Since

$$w_H - \frac{w_H + w_L}{2} p(a_{low}^*) > \frac{1}{2} (w_H - w_L) \Leftrightarrow \frac{1}{2} (w_H + w_L) [1 - p(a_{low}^*)] > 0$$

is true and $h(\cdot)$ is monotonically increasing, we must have that $a_{low}^* > a_{no}^*$. Inspection of (3) and (11) shows that $a_{no}^* > a_{high}^*$, if and only if w_L is smaller than the cut-off value $\bar{w}_L \in [0, w_H)$ described by

$$\frac{1}{2} (w_H - \bar{w}_L) = \frac{w_H + \bar{w}_L}{2} p(a_{high}^*) \Leftrightarrow \bar{w}_L = \frac{1 - p(a_{high}^*)}{1 + p(a_{high}^*)} w_H.$$

■

As a_{low}^* and a_{no}^* decrease in w_L , but a_{high}^* increases in w_L , there will be a clear ranking between the three equilibrium efforts, if the impact of the loser prize w_L is negligible. In particular, under a zero loser prize w_L efforts can be unambiguously ranked as $a_{low}^* > a_{no}^* > a_{high}^*$. The reaction functions (5), (6), (9) and (10) give a clear intuition for this ranking. In case of low bankruptcy risk (i.e., $\bar{\Pi} \in (2\pi_L, \pi_L + \pi_H]$), tournament efforts are strategic substitutes in the sense of Bulow et al. (1985) so that more aggressive behavior by one worker decreases the activity level of the other player. Since each worker wants to make use of this strategic effect, in equilibrium both end up in a situation with higher effort levels compared to the benchmark case without bankruptcy: $a_{low}^* > a_{no}^*$. However, if workers face a high bankruptcy risk (i.e., $\bar{\Pi} \in (\pi_L + \pi_H, 2\pi_H]$), tournament efforts are strategic complements: Less effort by one of the workers induces less effort by the other worker. As both players make use of this strategic effect, in equilibrium they behave less aggressively than in the benchmark case without bankruptcy: $a_{high}^* < a_{no}^*$. In this situation, the workers' interests are perfectly aligned since they must be successful

⁶Note that condition (1) can be rewritten as $\frac{d}{da_i} \left(\frac{h(a_i)}{p(a_i)} \right) > 0$.

⁷Note that including this equilibrium would not alter the ranking of equilibrium efforts of the three scenarios under a zero loser prize. Moreover, the puzzling finding of excessive oversupply of effort under high bankruptcy risk in the experiment would even be reinforced.

⁸Since we focus on the impact of bankruptcy risk on work incentives, career incomes w_L and w_H are exogeneously given.

as a team in order to guarantee survival of the firm. However, teamwork suffers from free riding, which also appears in the given context.

4 Experimental Design

In our experiment, we tested the theoretical settings described above: a tournament with high, low or no bankruptcy risk. All treatments consisted of a one-shot tournament between two players. Both contestants could either achieve state A (symbolizing π_H in the experiment) or state B (standing for π_L in the experiment) which affected the chances of winning the tournament as well as the risk of bankruptcy. The players simultaneously selected a number of points between zero and 100. The chosen points divided by 100 yield the probability of the player to achieve state A rather than state B in the experiment. For example, if a player chose 50 points his chance of ending up in state A was 50%. However, choosing a high number of points led to higher costs than choosing a smaller number. These costs were calculated as $c(\text{points}) = \frac{200}{3} \left(\frac{\text{points}}{100}\right)^3$. In the experiment, we used the fictitious currency "Taler" and the players received an initial endowment of 75 Talers in all treatments. After having selected their number of points all participants had to state their beliefs about the chosen points of their opponents. The question about the beliefs was not announced in the instructions. The answer was not incentivized to prevent subjects from hedging their incomes by strategically announcing wrong beliefs. Information about the outcome of the tournament and the payoff was not revealed until the end of the experiment to prevent possible income effects on the answers to our control variables.

To retrieve control variables for the risk attitude, the participants had to complete ten paired lottery choice decisions from Holt and Laury (2002) which were also paid. Moreover, we used a simple set of lotteries proposed in Gaechter et al. (2007), in order to measure loss aversion. Each subject had to decide in six lotteries whether he wants to participate in the lottery or not. The winning prize was always six Talers while the loser prize varied between two and seven Talers. One of the lottery choices was selected for pay. All players answered a questionnaire containing questions on competitiveness (Smither and Houston, 1992), loss aversion, demographic details as well as open questions where the decision about effort could be explained.

Corresponding to the theoretical settings we ran three treatments labeled "high", "low" and "no", respectively. The three treatments only differed in the probability to go bankrupt. In the no-treatment, there was no risk of bankruptcy. Here, the player with the better performance got the winner prize of 100 Talers while the loser got zero. Ties were broken randomly. Hence, if one player was in state A and the other in state B, the player in state A received 100 Talers and the player in state B got zero Talers. If both were in state A or both were in state B, a random draw decided which player got the winner prize. In

the low-treatment, the setting was exactly the same but at least one player had to achieve state A in order to avoid bankruptcy. If both players were in state B, they received zero Talers. In contrast, both players had to achieve state A in the high-treatment to avoid bankruptcy. If at least one player had not achieved state A, both got nothing. If both were in state A, a random draw decided who received the winner prize. Table 1 summarizes the experimental parameters and the resulting equilibrium predictions. For the computation of the equilibrium efforts a_{low}^* , a_{no}^* and a_{high}^* , we have to use our specifications $p(a_i) = a_i$ and $c(a_i) = \frac{200}{3}a_i^3$ together with the special values of winner and loser prizes (i.e., $w_H = 100$ and $w_L = 0$). Note that we set the loser prize equal to zero in order to guarantee a clear-cut analysis of the basic model. As has been pointed out above, a positive loser prize would lead to opposite incentives in the high-treatment on the one hand and the low- and no-treatments on the other hand.⁹ The points in equilibrium presented in Table 1 are obtained by multiplying a_{low}^* , a_{no}^* and a_{high}^* by 100. In the experiment, each subject chose discrete effort points from the set $\{0, 5, 10, 15, 20, \dots, 100\}$. The incremental steps of 5 points lead to an additional equilibrium in the high-treatment where both players choose 20. However, this equilibrium is Pareto dominated and, therefore, excluded in the following.¹⁰ In all treatments, the costs of the chosen points were deducted from the payoff of the participants.

At the outset of each session, all players were randomly assigned to a cubicle. The instructions were explained by the experimenter.¹¹

| Treatment | high | no | low |
|-----------------------|-----------------------------------|-------|----------------------------|
| w_H | 100 | 100 | 100 |
| w_L | 0 | 0 | 0 |
| bankruptcy | at least one player in state B | never | both players in state B |
| points in equilibrium | 25 | 50 | 60 |

Table 1: Experimental parameters and the resulting equilibrium predictions

We used neutral language all the time and avoided any value-laden terms like "winner", "loser", "tournament prize" or "bankruptcy". Before the experiment started, the participants completed a short quiz to check the understanding of the instructions. The players also had the opportunity to ask clarifying questions. Communications among the participants were not allowed. The whole procedure took about 1.5 hours. On average,

⁹In Section 7, we present experimental findings on the low-treatment that include positive loser prizes.

¹⁰Note that, in analogy to the zero-effort equilibrium in the high-treatment, including this equilibrium would even strengthen our main findings on excessive effort supply.

¹¹The instructions can be obtained from the authors upon request.

the players earned 16.06 Euro (approx. 20.40 USD at the time of the experiment) including a show-up fee of four Euros. The exchange rate was one Euro for eight Talers. We conducted 7 sessions for each treatment with 24 players in each session.¹² The players received information about the outcome of the tournament only at the end of the experiment.

The experiment was conducted at the BonnEconLab and the programming language was z-tree (Fischbacher, 2007). Altogether 482 players participated in the experiment. As we employed a between-subjects one shot design, each player was allowed to attend one session only. All of the participant have been enrolled as students at the University of Bonn.

5 Hypotheses

At first sight, it is not clear how subjects react to the perils of going bankrupt. On the one hand, subjects may choose higher efforts compared to a sure career system because they want to avoid states where the investments in their corporate careers (i.e., effort choices) as well as their future incomes get lost. On the other hand, the probability of going bankrupt decreases expected career incomes compared to a sure career system. Moreover, making the firm survive is a public good that is produced by both subjects together. These two effects can lead to effort levels that are lower than efforts under a sure career system.

The theoretical results of Section 3 show that we obtain clear-cut results. Depending on whether effort choices are strategic substitutes – as in the low-treatment –, or strategic complements – as in the high-treatment –, subjects should choose higher or lower effort levels compared to the standard case with no bankruptcy risk. These results are summarized in Proposition 1 and tested as our first hypothesis, which uses the equilibrium results for the parameterized model displayed in the last line of Table 1:

Hypothesis 1: When deciding on efforts, subjects in the high-treatment will select 25 points, subjects in the no-treatment 50 points and subjects in the low-treatment will choose 60 points.

Previous experiments have shown that players tend to oversupply effort in tournament settings so that subjects may systematically deviate from the theoretical efforts in our experiment as well (Schotter and Weigelt, 1992). Nevertheless, Proposition 1 yields a clear ordinal ranking of equilibrium efforts, which should be maintained in the experiment even if there is systematic deviation towards higher effort levels in all treatments. The following hypothesis summarizes this claim:

¹²In some sessions we had less than 24 participants because some players did not show up.

Hypothesis 2: The selected effort levels are lowest in the high-treatment and highest in the treatment labeled low. Hence, we expect the following order of selected points on average: $points\ high-treatment < points\ no-treatment < points\ low-treatment$.

6 Experimental Results

We tested our hypotheses with data from the experiment starting with Hypothesis 1. As can already be seen in Figure 1, the average effort level in the high-treatment was 56.03 points, for the no-treatment it was 61.51 and in the low-treatment we observed an average effort level of 66.19 points. All reported effort levels are significantly higher than the respective theoretical prediction (one sample mean comparison test: high $p = 0.000$; base $p = 0.000$, low $p = 0.001$). Hence, we have to reject Hypothesis 1. This finding is well in line with results from previous tournament experiments. For example, Schotter and Weigelt (1992), Harbring and Irlenbusch (2005), Harbring et al. (2007), Harbring and Lünser (2008), and Eriksson et al. (2009) report a oversupply of effort in the lab. However, the deviation from the theoretically predicted value is significantly larger in the high-treatment than in the low- or no-treatment (see Figure 1 and pairwise Mann-Whitney-U tests: both $p = 0.000$). In fact, in the high-treatment average effort exceeds the theoretical effort level by more than 124%, which is a very high deviation compared to oversupply of effort in both the two other treatments and the findings in previous tournament experiments. This observation is even more remarkable when we take into account that we used a cubic cost-of-effort function, whereas previous experiments typically apply only quadratic costs.

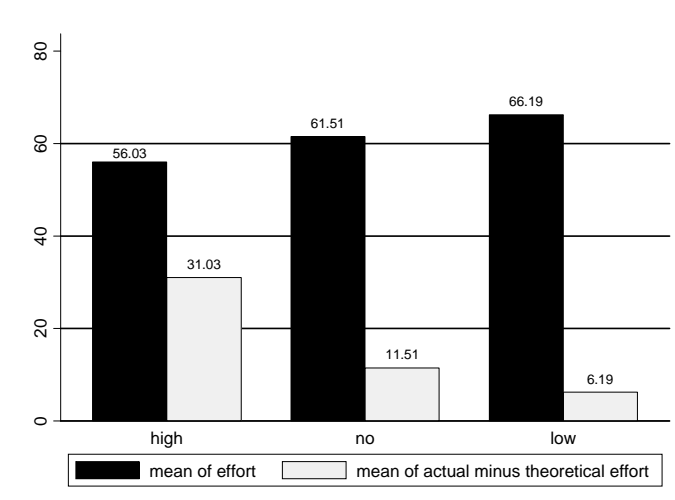


Figure 1: Mean of actual effort and difference of actual and theoretical effort by treatment

Oversupply of effort in the two bankruptcy treatments high and low has clear consequences for the survival rates of the firms in the lab. These consequences are pro-

found for the high-treatment. While the theoretically predicted probability to survive is $(a_{high}^*)^2 = 6.25\%$ in the high-treatment it is five times larger in the experiment (31.29%). In contrast, the firm's survival probability in the low-treatment is 87.88% in the experiment which anyhow is larger than the theoretical value of $2a_{low}^*(1 - a_{low}^*) + (a_{low}^*)^2 = 84\%$.

Result 1: *In all treatments, players selected significantly higher effort levels than theoretically predicted. Hence, we have to reject Hypothesis 1. The deviation from the theoretical prediction in the high-treatment was significantly larger than the deviation in the two other treatments.*

| | OLS | Tobit |
|-------------------------|---------------------|---------------------|
| | (1) | (2) |
| Dummy no-treatment | 5.721** (2.421) | 7.301** (2.828) |
| Dummy low-treatment | 6.887*** (2.348) | 8.338*** (2.740) |
| # of safe choices (H&L) | 0.190 (0.575) | 0.260 (0.675) |
| Loss aversion | -0.739 (0.765) | -0.726 (0.901) |
| Competitiveness | -0.174 (0.228) | -0.203 (0.269) |
| Reaching state A | 34.04*** (3.231) | 38.27*** (3.886) |
| Gender | -0.229 (2.056) | -0.269 (2.413) |
| Dummy study economics | -2.817 (2.420) | -3.865 (2.753) |
| Constant | 27.72*** (6.498) | 24.06*** (7.708) |
| Observations | 482 | 482 |
| (Pseudo) R^2 | 0.281 | 0.0360 |

Dependent variable is effort. Reference category is high.

Robust standard errors in parentheses.

***p < 0.01, **p < 0.05, *p < 0.1

Table 2: Comparison of effort between treatments

To investigate Hypothesis 2, we check the ranking of efforts of the different treatments. The observation of Figure 1 indicates that the results support Hypothesis 2, which is confirmed by a Jonckheere-Treppstra Test (ascending order $p = 0.000$). Further confirmation comes from the regressions reported in Table 2. The dependent variable in both regressions is effort. We included dummy variables which are 1 for the no- resp. the low-treatment and zero otherwise. Hence, the high-treatment serves as the reference category in these regressions. The results of an OLS regression are reported in the first specification but since our data are censored, we also use a Tobit regression and report our findings in the second column of Table 2. The results do not differ qualitatively. As expected, both dummies are positive and significant. We also included several control variables for risk attitude, loss aversion, competitiveness and demographic details in the regression. None of the control variables has a significant impact on the effort selected in the experiment. Additionally, we also added a dummy variable called "reaching state A". It takes value one if the subjects reported a 6 – 10 on a scale from zero to 10 when asked to agree with the statement "I wanted to reach state A". Zero denoted "does not apply at all" while 10 indicates "applies perfectly". As could be expected, the dummy is highly significant. If the players state that they wanted to reach state A, they selected higher effort levels. However, we could not detect any interaction effects between specific treatments and the desire to reach state A. Furthermore, we did not find significant differences between the answers to this statement in different treatments (Mann-Whitney-U test).

Result 2: *The players correctly adjusted their efforts to the risk of bankruptcy. If the risk of bankruptcy was high, the players selected significantly lower effort levels than if the risk of bankruptcy was low or absent. Hence, the data support Hypothesis 2.*

Since we also elicited the beliefs of the players about the chosen effort levels of their opponents, we are able to check if the players selected the optimal effort given their belief. The Figures 2, 3, and 4 show scatterplots of belief and chosen effort for all three treatments as well as the best response for a given belief, calculated according to the theoretical model discussed above. The reaction curve summarizes all these best responses for each treatment. In the high treatment, the reaction curve is increasing as efforts of both contestants are strategic complements, while the curve is decreasing in the low-treatment indicating strategic substitutes. Due to dominant strategies, the best response to every belief is 50 in the no-treatment. As can already be seen in Figures 2, 3, and 4, the correlations between chosen effort and belief are positive and significant for each treatment (Spearman's rank correlation: high-treatment: $\rho = 0.6685^{***}$, no-treatment: $\rho = 0.5302^{***}$, low-treatment: $\rho = 0.4892^{***}$). Hence, regarding the no- and the low-treatment, the findings are not in line with theory.

Despite the last observation, the ranking of chosen efforts in the three treatments is perfectly in line with theory. In particular, subjects chose significantly more effort in the low-treatment than in the high-treatment although best responses did not follow the interaction of strategic substitutes in the low-treatment. The scatterplots in Figures 2 and 4 give a first hint, why the observed relation and the theoretic relation between a_{high}^* and a_{low}^* coincide. As theoretically predicted, in the high-treatment subjects' behavior followed the reactions of strategic complements. Hence, if a player anticipated high (low) effort of his opponent he should also choose high (low) effort accordingly. As Figure 2 points out, the majority of players expected high efforts by the other players and correctly reacted by choosing high efforts as well. Actually, the two players were no longer in a tournament situation under high bankruptcy risk but acted as team to make the firm survive. Only if both players were successful and reached state A, each one could expect the positive payoff $w_H/2$. Since most of the subjects expected their counterparts to be mainly interested in protecting the firm's survival it was rational to work into the same direction.

Nevertheless, subjects still chose significantly more effort in the low-treatment. Recall that in the experiment subjects' efforts follow strategic complements according to Spearman's rank correlation. Since more subjects had high effort beliefs in the low-treatment than in the high-treatment (126 subjects had effort beliefs of at least 50 points in the high-treatment, whereas this number was 151 and, hence, significantly larger for the low-treatment (Fisher-Test, $p = 0.003$)), it is consequent that high effort levels were more often observed as complementary reactions in the low-treatment than in the high-treatment. There were two driving forces that let subjects expect high efforts in the low treatment. First, both players were interested in avoiding firm bankruptcy. Second, given survival of the firm each player had still the chance to outperform his opponent, which was impossible under high bankruptcy risk. Thus, intuitively it seems plausible why more subjects had higher beliefs in the low-treatment than in the high-treatment.

However, the interpretations of the scatterplots should be interpreted carefully. First, we only have one observation of each subject in the scatterplots. Second, as most subjects reported their opponent would select a high effort level, there is only little information on how subjects react to low beliefs. Third, based on the Kolmogorov-Smirnov test we have to reject the hypothesis that the theoretic reaction curve coincides with our data ($p = 0.000$ for all three treatments). Therefore, it is necessary to look for an alternative theoretical framework that describes individual behavior better than the basic model of Section 2.

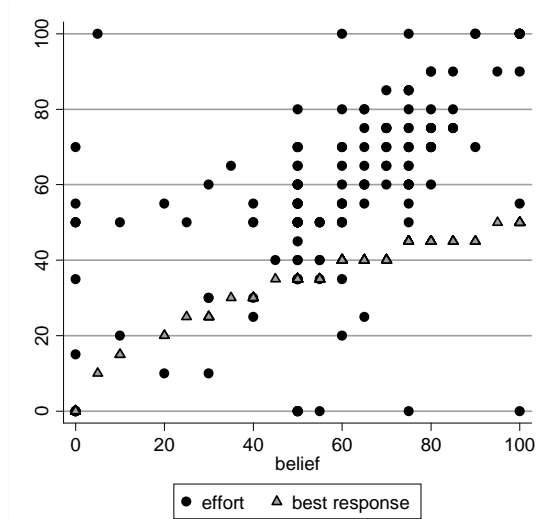


Figure 2: scatterplot belief/effort and reaction curve for high-treatment

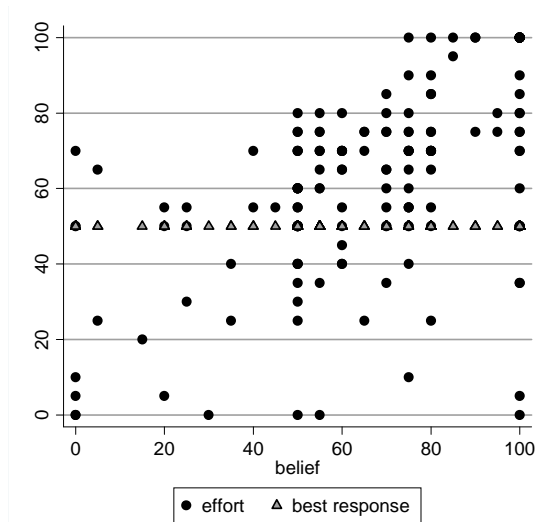


Figure 3: scatterplot belief/effort and reaction curve for no-treatment

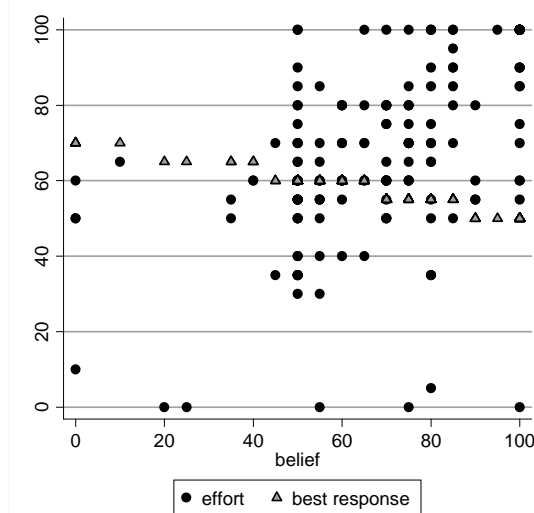


Figure 4: scatterplot belief/effort and reaction curve for low-treatment

To sum up, our data are qualitatively in line with the theoretical results of Proposition 1. In particular, we exactly find the predicted ranking between the effort levels of the three treatments. Two remarkable results must be emphasized, which both refer to the high-treatment: First, subjects supplied more than twice as much effort as theoretically predicted. Second and related to the first issue, this doubling of exerted effort in the high-treatment spills over to the firm’s survival probability, which becomes more than five times higher than in equilibrium. These two observations indicate that a positive risk of bankruptcy also has behavioral implications that are not completely covered by the basic model of Section 2, which assumes traditional textbook preferences for the contestants. We will discuss possible implications in the next section.

7 Discussion

The starting point for this section is the major puzzling observation in the high-treatment: In that treatment, subjects’ efforts were more than twice as high compared to theory. This deviation from the equilibrium effort level is significantly larger than the deviations in the two other treatments and also larger than the deviations documented in other tournament experiments. Larger deviation in the high-treatment than in the low-treatment may be explained by the findings of Irlenbusch and Ruchala (2008). In their experiment, Irlenbusch and Ruchala compare effort provision under pure team compensation with efforts under a compensation scheme that is based on both team performance and relative performance of the team members. The experimental results suggest that relative rewards crowd out voluntary effort supply in teams. Since the high-treatment describes a pure team problem whereas the low-treatment combines team issues with relative perfor-

mance pay, the findings of Irlenbusch and Ruchala may analogously apply to our results. However, the possible analogy cannot explain why subjects chose excessive effort in the high-treatment. In the following, we will discuss three possible explanations for this puzzle that seem most plausible to us.¹³

7.1 Efficiency Concerns

Since de facto the two workers are made collectively responsible for the survival of the firm, this responsibility may lead them to care for Pareto efficiency. Hence, instead of choosing pure Nash equilibrium strategies, workers may be geared to efficient effort levels and distort their effort decisions upwards. As outputs π_H and π_L were not part of the experiment, the subjects were not able to exactly calculate efficient effort levels in the experiment. However, subjects should be aware of the fact that efficient levels are typically higher than Nash equilibrium efforts and they were able to ordinally rank efficient effort levels. Let e_t^{eff} denote the ordinal efficient effort level in treatment $t \in \{no, low, high\}$. If subjects expected effort points to be higher than 50 in the high- and the low-treatments – recall that on average chosen points are significantly higher than 50 in both treatments – then efficient efforts have to be ranked as follows:¹⁴

$$a_{high}^{eff} > a_{low}^{eff} \geq a_{no}^{eff}$$

Hence, efficiency concerns may have influenced the subjects' effort choices so that very high efforts were spent in the high-treatment. This approach may have some explanatory power, but theoretically optimal effort levels as well as chosen effort levels in the experiment are ranked according to $a_{low}^* > a_{no}^* > a_{high}^*$. Thus, efficiency concerns cannot be the most important motive for the subjects in the end.

7.2 Loss Aversion

Loss aversion can become particularly important for individuals if there exist possible situations where their incomes get lost although they spent a very large effort and, hence, are not responsible for the loss. In the given setting, we have situations in which individuals lose their incomes due to bankruptcy. In addition, there are also situations where both individuals realize a high output so that the tournament winner is determined by tossing a fair coin. Again, a player is not responsible for losing the winner prize in this situation. Recall that we controlled for loss aversion in our regressions (see Table 2)

¹³Note that risk attitude, competitiveness and inequity aversion did not have a significant impact on the subjects' effort choices, as documented by the regression results in Table 2.

¹⁴Our data show that if beliefs about effort points are greater or equal than 50, chosen points are significantly larger than 50 in the two bankruptcy treatments (see Figures 2 and 4). For the ordinal ranking of efficient effort levels see Appendix A.

and did not find a significant influence. However, we could only test loss aversion in a fairly general context without a concrete reference point. We applied the test offered by Gaechter et al. (2007), who rather cautiously states that his procedure "arguably" measures loss aversion.¹⁵ Moreover, in our experiment subjects had a clear candidate reference point – their initial endowment –, which is not part of the test by Gaechter et al. (2007).

Suppose that subjects in the experiment compared their realized incomes with a certain reference income, Y^R . In that case, it is plausible that Y^R was the subjects' initial endowment (i.e., 75 Talers). Under the given reference income of 75 Talers, subjects' net income in our setting with $w_H = 100$ and $w_L = 0$ was larger than Y^R in case of winning w_H (even if a subject chose maximal effort) and smaller than Y^R in case of losing against the opponent or going bankrupt. In the latter cases, the subject ended up with realized net income $-c(a_i)$. We assume that a loss averse subject's preferences can be described by the following linearly kinked utility function:¹⁶

$$U(Y) = \begin{cases} Y & \text{if } Y > Y^R \\ Y - l \cdot (Y^R - Y) & \text{if } Y \leq Y^R \end{cases} \quad (12)$$

with Y as a subject's realized net income (i.e., tournament prize minus effort costs) and $l \in (0, 1)$ as given loss aversion parameter. Applying the utility function described by (12) to the workers' optimal effort choices in the three treatments no, low and high yields the effort ranking¹⁷

$$\tilde{a}_{low}^* > \tilde{a}_{no}^* > \tilde{a}_{high}^*.$$

Contrary to the case of efficiency concerns, this ranking coincides with that in the basic model, which was identical to the ranking of subjects' effort choices in the experiment. However, as the discussion in Appendix B points out, the observation of excessive effort supply in the high-treatment can hardly be explained by loss aversion since the impact of loss aversion on incentives crucially depends on the magnitude of the reference income and in the given context a discouraging effect of loss aversion on effort choice seems plausible.

¹⁵Additionally, we also had two questions dealing with loss aversion in the questionnaire. As the answers are correlated with each other and with the measure of Gaechter et al. (2007), we can only add one of it in the regressions. None of the measures has a significant impact on effort provision.

¹⁶Preferences based on reference points and loss aversion are described by the prospect theory introduced by Kahneman and Tversky (1979). See Tversky and Kahneman (1991) especially on loss aversion. For the case of a linear and kinked utility function characterizing loss aversion see, among many others, Barberis et al. (2001), DeMeza and Webb (2007), p. 70, and Gill and Stone (2010). The concept of loss aversion suggested by Köszegi and Rabin (2006) deals with an endogenously determined reference point. Since in our experiment an exogenous reference income in form of the subjects' initial endowment seems very plausible and analytically tractable in the lab, we applied the first concept.

¹⁷See Appendix B.

7.3 Disutility of Bankruptcy

We suppose that subjects felt uncomfortable being confronted with a possible situation where zero income was paid out to both of them. Throughout the experiment we used neutral language and did not label such state "going bankrupt" but the subjects clearly realized under which outcomes no one earned the career incomes w_L and w_H . Therefore, we conjecture that subjects felt some disutility of facing the possibility of collectively losing $w_L + w_H$. In order to include this disutility in the workers' objective functions we subtract the function $D(w_L + w_H, P)$ from (2), (4) and (8), respectively. This function characterizes a worker's disutility of bankruptcy with $w_L + w_H$ describing the collective loss in this case and P the probability of bankruptcy, which depends on the given treatment. We assume that $D(0, P) = \bar{D} > 0$ and $D(w_L + w_H, 0) = 0$ (i.e., the bankruptcy event itself generates some disutility, which becomes zero if the event is impossible). Moreover, $D(w_L + w_H, P)$ is assumed to be monotonically increasing in both arguments (i.e., $D_1, D_2 > 0$: the higher the collective loss in case of bankruptcy and the more likely this event the higher will be a worker's disutility), with $D_{11}, D_{22} \geq 0$.

Let \hat{a}_t^* denote the equilibrium effort of the workers in treatment $t \in \{no, low, high\}$ under the new objective function that incorporates disutility of bankruptcy. If subjects value monetary income stronger than their negative feelings on bankruptcy, these efforts compare as follows:¹⁸

$$\hat{a}_{low}^* > \hat{a}_{no}^* > \hat{a}_{high}^*.$$

This ranking coincides with the ranking of observed average efforts in our experiment. As major puzzle, the data emphasized that subjects deviated more strongly from predicted effort in the high-treatment than in the low-treatment. In fact, chosen effort was more than twice as high in the high-treatment compared to the equilibrium effort level, but in the low-treatment subjects only realized efforts that exceeded the theoretical value by about 9 percent. In Appendix C we show that introducing disutility of bankruptcy leads to extra incentives in both the high- and the low-treatments, but under a generally high level of chosen efforts – which is documented for all treatments – the effort-enhancing effect of $D(w_L + w_H, P)$ is clearly stronger in the high-treatment. Intuitively, when choosing effort the marginal benefit of reducing one's own disutility of bankruptcy, $\partial D(w_L + w_H, P) / \partial a_i$, determines the extra incentives from bankruptcy. Since this marginal benefit increases in the effort level of co-workers in the high-treatment and decreases in the efforts of co-workers in the low-treatment, introducing a disutility-of-bankruptcy function into the basic model can explain the observed puzzle because efforts as well as effort beliefs are high in the two bankruptcy treatments (see Figures 2 and 4).

In order to further test our approach we ran additional treatments with a positive loser prize $w_L > 0$. In the basic model, we show that a_{high}^* increases in w_L , but a_{low}^*

¹⁸See Appendix C.

decreases in w_L . From Appendix C we know that extra incentives from bankruptcy increase in w_L in both the high-treatment and the low-treatment.¹⁹ Therefore, testing the high-treatment with a positive loser prize is not informative at all: If effort increases compared to average effort under a zero loser prize this finding will be in line with both the basic model and the disutility-of-bankruptcy approach; if effort decreases, this result would contradict both theoretical settings. However, if introducing a positive loser prize into the low-treatment yields larger or equal efforts compared to the setting with a zero loser prize, such finding would contradict the basic model and be in line with the disutility-of-bankruptcy model. For these reasons, we used the low-treatment instead of the high-treatment as starting point to test our disutility-of-bankruptcy approach.

We designed two additional treatments labeled low-45 and low-90 which are similar to the low-treatment. The only change is that we introduced a positive loser prize of 45 Talers in the low-45 and of 90 Talers in the low-90 treatment. Both prizes were only paid to the loser of the tournament if at least one player was in state A so that the firm did not go bankrupt. Following theory, the equilibrium effort level is 55 points for the low-45 and 50 points for the low-90 treatment. We conducted three sessions in the BonnEconLab for each treatment. The setup was similar to the other treatments described above.

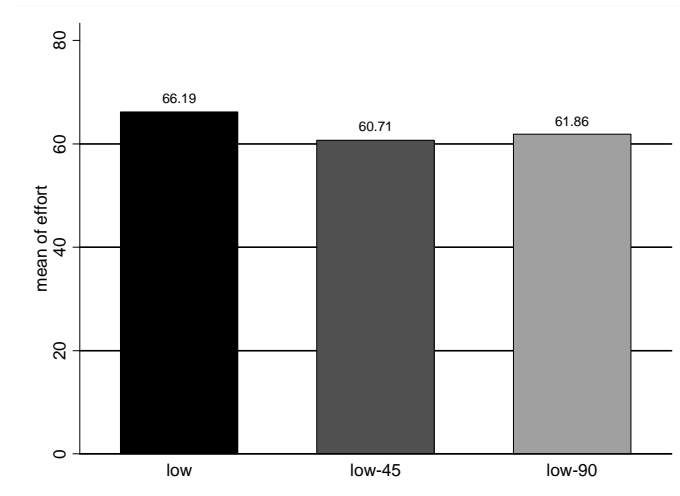


Figure 5: Mean of effort in the low-treatments

The results of the additional sessions as well as those of the original low-treatment can be seen in Figure 5. A pairwise comparison of the efforts of the three treatments does not show a significant difference (Mann-Whitney-U test). This result is supported by the regressions reported in table 3. Again, effort is the dependent variable and we control for risk attitudes, loss aversion, competitiveness and demographic details. The reference category is the low-treatment and we included dummy variables for the low-45

¹⁹Let $\partial^2 D(w_L + w_H, P) / \partial a_i \partial w_L$ denote the mixed partial derivative with respect to effort and loser prize. In Appendix C, we see that this derivative is positive for the low-treatment as well as for the high-treatment in equations (20) and (22), respectively.

and the low-90 treatment. As expected, the dummy variables are not significant. Hence, the subjects did not reduce effort if positive loser prizes were paid. Even if the loser prize is close to the size of the winner prize (low-90 treatment), which sharply cuts incentives in the basic model, the subjects did not reduce effort levels.

| | OLS | Tobit |
|-------------------------|---------------------|---------------------|
| | (1) | (2) |
| Dummy low-45 | -1.020 (2.967) | -1.370 (3.278) |
| Dummy low-90 | 0.288 (3.044) | -0.184 (3.421) |
| # of safe choices (H&L) | -0.475 (0.716) | -0.456 (0.831) |
| Loss aversion | -0.192 (0.971) | -0.169 (1.128) |
| Competitiveness | -0.170 (0.277) | -0.153 (0.321) |
| Reaching state A | 32.37*** (3.984) | 34.88*** (4.404) |
| Gender | 0.541 (2.551) | 1.580 (2.892) |
| Dummy study economics | 0.508 (2.516) | -0.249 (2.762) |
| Constant | 40.59*** (7.655) | 38.96*** (8.830) |
| Observations | 306 | 306 |
| (Pseudo) R^2 | 0.255 | 0.0319 |

Dependent variable is effort. Reference category is low.

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3: Comparison of effort between treatments

To summarize, our findings are not in line with the prediction of the basic model. Instead they support the reasoning of the disutility-of-bankruptcy approach: Since efforts in the three low-treatments do not significantly differ, the introduction of a positive loser prize leads to two opposing effects, which just offset each other. The loser prize $w_L = 45$ decreases the prize spread $w_H - w_L$, which partly destroys standard tournament incentives.

At the same time, w_L increases the disutility of bankruptcy $D(w_L + w_H, P)$ which boosts incentives as individuals try to avoid the event of going bankrupt. The data indicate that both effects nearly compensate each other. Further increasing the loser prize to $w_L = 90$ in the low-90 treatment still leads to the same average effort as the low-treatment with zero loser prize. Here, standard tournament incentives are even lower than in low-45, but additional incentives via $D(w_L + w_H, P)$ further increase. Again, both effects nearly offset one another. In this situation, standard tournament incentives become negligible as the gain of winning, given by the prize spread $w_H - w_L = 10$, is only worth 1.25 Euro. Nevertheless, average effort even slightly increases compared to low-45, which shows that incentives due to bankruptcy will be important if the stakes are rather high (i.e., career incomes at risk, $w_L + w_H = 190$ corresponding to 23.75 Euro, are large).

8 Conclusion

The theoretical and experimental results of our paper have shown that the degree of a firm's bankruptcy risk significantly influences worker behavior. The theoretical part of the paper shows that effort choices are strategic complements under high risk of bankruptcy which yields rather poor incentives for the workers compared to a situation without bankruptcy risk. However, efforts are strategic substitutes and highest if the firm faces a low risk of bankruptcy. Our experimental findings confirm the expected effort ranking for high, no and low bankruptcy risk. The experiment also points to a puzzle: Subjects chose twice as much effort than the equilibrium level if bankruptcy risk is high, although effort costs are described by a very steep function.²⁰ This oversupply of effort influences the firm's survival probability, which becomes five times higher than predicted. We conjecture that the anticipated possibility of firm bankruptcy leads to an additional disutility for the workers. In order to decrease this disutility they choose more effort compared to a setting with standard textbook preferences.

In a second step, we tested our disutility-of-bankruptcy approach by running two additional treatments. In the three basic treatments high, no and low we normalized the loser prize to zero and consider a winner-take-all contest for job promotion. In the two additional treatments, we introduced a – low respectively high – positive loser prize into the basic setting with low bankruptcy risk. The resulting average efforts do not significantly differ from the average effort in the low-bankruptcy treatment with zero loser prize. Even if the loser prize becomes so large that the tournament prize spread is negligible, incentives do not significantly differ from the basic treatment with zero loser prize. These observations are in line with our disutility-of-bankruptcy approach where direct monetary incentives via the prize spread are replaced by incentives to ensure firm survival and,

²⁰Recall that we used a cubic cost function in the experiment, whereas previous experiments on tournaments and contests usually apply a linear or a quadratic cost function.

hence, to protect workers' collective wage bill. Our finding has a clear implication for the wage policy of a firm: Introducing prizes for tournament losers has positive incentive effects under the shadow of bankruptcy, which clearly differs from behavior in tournaments without bankruptcy as well as predicted behavior under moderate bankruptcy risk and standard textbook preferences. However, since monetary incentives and incentives due to bankruptcy just offset each other, it is still optimal for the firm to save labor costs and withdraw loser prizes. Hence, a wage policy that induces strong long-term incentives via large hierarchical wage differentials and corporate careers is still optimal under the shadow of bankruptcy as long as typical negative implications of corporate tournaments such as sabotaging and influence activities do not become too intense.

Our experimental findings lead to two further implications. First, the results of the high-bankruptcy treatment indicate that an initial crisis of a firm does not automatically imply an even larger crisis at the end, caused by worker discouragement or free riding. On the contrary, if a firm gets into trouble, employees work hard as a team to prevent their firm from filing for bankruptcy. In other words, a firm crisis and the possibility of bankruptcy may strengthen group coherence among the workforce. Second, shareholders can influence the firm's probability of a bankruptcy by issuing debt. According to our theoretical and experimental results, switching from 100% equity to a moderate debt-equity ratio is beneficial for the shareholders in order to increase overall incentives and, therefore, workers' efforts. In the introduction, we referred to corporate finance papers (in particular, Grossman and Hart, 1982) that suggest debt as an instrument for creating managerial incentives. The results of our paper indicate that debt can be useful for strengthening workers' incentives as well.

Appendix

Appendix A: Efficiency Concerns

In the *no-treatment*, efficient effort maximizes the welfare function

$$2\pi_H p(a_i) p(a_j) + (\pi_H + \pi_L) [p(a_i) (1 - p(a_j)) + (1 - p(a_i)) p(a_j)] \\ + 2\pi_L (1 - p(a_i)) (1 - p(a_j)) - c(a_i) - c(a_j).$$

Since the welfare function is strictly concave in both workers' efforts, the efficient cardinal effort level \hat{a}_{no}^{eff} is described by the first-order condition of each worker, which can be rewritten as

$$\pi_H - \pi_L = h(\hat{a}_{no}^{eff}). \quad (13)$$

In the *low-treatment*, the welfare function is given by

$$2\pi_H p(a_i) p(a_j) + (\pi_H + \pi_L) [p(a_i) (1 - p(a_j)) + (1 - p(a_i)) p(a_j)] \\ - c(a_i) - c(a_j).$$

The workers' first-order conditions yield the efficient cardinal effort level \hat{a}_{low}^{eff} implicitly described by

$$\pi_H + \pi_L \left[1 - 2p(\hat{a}_{low}^{eff}) \right] = h(\hat{a}_{low}^{eff}). \quad (14)$$

As $\pi_H - \pi_L \leq \pi_H + \pi_L \left[1 - 2p(\hat{a}_{low}^{eff}) \right] \Leftrightarrow p(\hat{a}_{low}^{eff}) \leq 1$ is true, we obtain $\hat{a}_{low}^{eff} \geq \hat{a}_{no}^{eff}$.

In the *high-treatment*, the welfare function reads as $2\pi_H p(a_i) p(a_j) - c(a_i) - c(a_j)$ so that the efficient cardinal effort level \hat{a}_{high}^{eff} is characterized by

$$2\pi_H p(\hat{a}_{high}^{eff}) = h(\hat{a}_{high}^{eff}). \quad (15)$$

Comparing (14) and (15) shows that efficient effort will be higher in the high-treatment than in the low-treatment, if

$$2\pi_H p(\hat{a}_{high}^{eff}) > \pi_H + \pi_L \left[1 - 2p(\hat{a}_{low}^{eff}) \right] \\ \Leftrightarrow 0 > \pi_H \left[1 - 2p(\hat{a}_{high}^{eff}) \right] + \pi_L \left[1 - 2p(\hat{a}_{low}^{eff}) \right],$$

which is true for $\hat{a}_{high}^{eff}, \hat{a}_{low}^{eff} > 0.5$ under the parameterization in the experiment, implying ordinal efficient effort levels a_{high}^{eff} , a_{low}^{eff} and a_{no}^{eff} being ranked as follows: $a_{high}^{eff} > a_{low}^{eff} \geq a_{no}^{eff}$.

Appendix B: Loss Aversion

In the *no-treatment*, worker i maximizes expected utility²¹

$$\begin{aligned} & [w_H - c(a_i)] p(a_i) (1 - p(a_j)) - (1 - p(a_i)) p(a_j) [(1 + l) c(a_i) + lY^R] \\ & + [p(a_i) p(a_j) + (1 - p(a_i)) (1 - p(a_j))] \frac{1}{2} [[w_H - c(a_i)] - [(1 + l) c(a_i) + lY^R]]. \end{aligned}$$

Rearranging the first-order condition²² leads to

$$w_H + lY^R = [l(p(a_j) - p(a_i) + 1) + 2] h(a_i) - c(a_i) l.$$

Hence, in case of a symmetric equilibrium $(\tilde{a}_i^*, \tilde{a}_j^*) = (\tilde{a}_{no}^*, \tilde{a}_{no}^*)$,²³ equilibrium effort is implicitly described by

$$w_H + lY^R = (2 + l) h(\tilde{a}_{no}^*) - c(\tilde{a}_{no}^*) l. \quad (16)$$

It can easily be checked that for the functional forms used in the experiment,

$$p(a_i) = a_i \quad \text{and} \quad c(a_i) = \frac{200}{3} a_i^3, \quad (17)$$

the right-hand side of equation (16) is positive and monotonically increasing in effort. Thus, $\partial \tilde{a}_{no}^* / \partial (w_H + lY^R) > 0$.

In the *low-treatment*, worker i 's objective function is given by

$$\begin{aligned} & [w_H - c(a_i)] p(a_i) \left([1 - p(a_j)] + \frac{1}{2} p(a_j) \right) \\ & - [c(a_i) (1 + l) + lY^R] \left(\frac{1}{2} p(a_i) p(a_j) + [1 - p(a_i)] [1 - p(a_j)] + p(a_j) [1 - p(a_i)] \right). \end{aligned}$$

The first-order condition²⁴ yields

$$w_H + lY^R = \left(\frac{1 + l}{1 - \frac{1}{2} p(a_j)} - l p(a_i) \right) h(a_i) - c(a_i) l.$$

In the symmetric equilibrium, both workers exert effort \tilde{a}_{low}^* described by

$$w_H + lY^R = \left(\frac{1 + l}{1 - \frac{1}{2} p(\tilde{a}_{low}^*)} - l p(\tilde{a}_{low}^*) \right) h(\tilde{a}_{low}^*) - c(\tilde{a}_{low}^*) l. \quad (18)$$

²¹Note that, as in the basic model, the tournament winner will be chosen by a fair coin if both subjects have realized identical outputs.

²²The second-order condition is satisfied under the parameterized version used in the experiment (i.e., $c(a) = \frac{200}{3} a^3$ and $p(a) = a$).

²³Since players are homogeneous, a symmetric equilibrium is the most plausible one.

²⁴The second-order condition is satisfied.

Again, the right-hand side is positive and monotonically increasing in effort for the specification (17). When comparing (16) with (18) we see that

$$\begin{aligned} \frac{1+l}{1-\frac{1}{2}p(\tilde{a}_{low}^*)} - lp(\tilde{a}_{low}^*) < 2+l &\Leftrightarrow \frac{1}{2}lp(\tilde{a}_{low}^*)^2 < 1-p(\tilde{a}_{low}^*) + \frac{1}{2}lp(\tilde{a}_{low}^*) \\ \Leftrightarrow 0 < 2[1-p(\tilde{a}_{low}^*)] + lp(\tilde{a}_{low}^*)[1-p(\tilde{a}_{low}^*)] &\Leftrightarrow 0 < 2+lp(\tilde{a}_{low}^*) \end{aligned}$$

holds. Since the left-hand sides of (16) and (18) are identical, the monotonicity of the right-hand sides implies that $\tilde{a}_{low}^* > \tilde{a}_{no}^*$.

In the *high-treatment*, worker i maximizes

$$[w_H - c(a_i)] \frac{1}{2}p(a_i)p(a_j) - [c(a_i)(1+l) + lY^R] \left(1 - \frac{1}{2}p(a_i)p(a_j)\right).$$

The first-order condition²⁵ shows that in the symmetric equilibrium each worker exerts effort \tilde{a}_{high}^* implicitly given by²⁶

$$w_H + lY^R = \left(\frac{1+l}{\frac{1}{2}p(\tilde{a}_{high}^*)} - lp(\tilde{a}_{high}^*)\right) h(\tilde{a}_{high}^*) - c(\tilde{a}_{high}^*)l. \quad (19)$$

The comparison of (16) and (19) points out that

$$\frac{1+l}{\frac{1}{2}p(\tilde{a}_{high}^*)} - lp(\tilde{a}_{high}^*) > 2+l \Leftrightarrow 1-p(\tilde{a}_{high}^*) > \left((1+p(\tilde{a}_{high}^*))\frac{1}{2}p(\tilde{a}_{high}^*) - 1\right)l$$

is true since $(1+p(\tilde{a}_{high}^*))\frac{1}{2}p(\tilde{a}_{high}^*) - 1 < 0$. Because the left-hand sides of (16) and (19) are identical and the right-hand sides monotonically increase in effort choice, we must have that $\tilde{a}_{no}^* > \tilde{a}_{high}^*$.

Comparative statics with respect to the loss-aversion parameter l yield

$$\frac{\partial \tilde{a}_{high}^*}{\partial l} = \frac{Y^R - \left(\frac{1}{\frac{1}{2}p(\tilde{a}_{high}^*)} - p(\tilde{a}_{high}^*)\right) h(\tilde{a}_{high}^*) + c(\tilde{a}_{high}^*)}{\frac{\partial}{\partial \tilde{a}_{high}^*} \left(\left[\frac{(1+l)}{\frac{1}{2}p(\tilde{a}_{high}^*)} - lp(\tilde{a}_{high}^*)\right] h(\tilde{a}_{high}^*) - lc(\tilde{a}_{high}^*)\right)}.$$

We know from the previous analysis that the denominator is positive given our specification (17). Under (17), the numerator can be rewritten as $Y^R - \frac{400}{3}\tilde{a}_{high}^*(3-2(\tilde{a}_{high}^*)^2)$. The sign of this expression is not clear. It crucially depends on the magnitude of the reference income Y^R . Consider, for example, the case of $l = 0$ so that the equilibrium efforts under loss aversion coincide with those in the basic model. In that case, we obtain $\tilde{a}_{high}^* = 0.25$. When marginally introducing loss aversion in the basic model, the numerator is negative

²⁵The second-order condition holds.

²⁶Given (17), the right-hand side is positive and monotonically increasing in \tilde{a}_{high}^* .

for $Y^R = 75$ (i.e., initial endowment in the experiment) and positive for sufficiently higher reference incomes. Moreover, since chosen efforts in the experiment are about 0.56 on average so that $Y^R - \frac{400}{3}\tilde{a}_{high}^*(3 - 2(\tilde{a}_{high}^*)^2)$ is strictly negative for $Y^R = 75$, a negative impact of loss aversion on incentives seems plausible.

Appendix C: Disutility of Bankruptcy

In the *no-treatment*, subtracting $D(w_L + w_H, 0)$ from the previous objective function (2) does not alter the equilibrium effort. Hence, both workers are again expected to exert effort $a_{no}^* =: \hat{a}_{no}^*$ being described by (3).

In the *low-treatment*, we have $P = (1 - p(a_i))(1 - p(a_j))$ so that the modified objective function of worker i ,

$$w_H p(a_i)(1 - p(a_j)) + \frac{w_H + w_L}{2} p(a_i) p(a_j) + w_L p(a_j)(1 - p(a_i)) - c(a_i) - D(w_L + w_H, (1 - p(a_i))(1 - p(a_j))),$$

yields the first-order condition

$$w_H - \frac{w_H + w_L}{2} p(a_j) + D_2(w_L + w_H, (1 - p(a_i))(1 - p(a_j)))(1 - p(a_j)) = h(a_i) \quad (20)$$

with $D_2(\cdot, \cdot)$ describing the derivative of the function $D(\cdot, \cdot)$ with respect to its second argument. Let \hat{a}_{low}^* denote a worker's effort choice in the corresponding symmetric equilibrium with

$$w_H - \frac{w_H + w_L}{2} p(\hat{a}_{low}^*) + D_2(w_L + w_H, (1 - p(\hat{a}_{low}^*))^2)(1 - p(\hat{a}_{low}^*)) = h(\hat{a}_{low}^*). \quad (21)$$

Comparison with (7) immediately points out that $\hat{a}_{low}^* > a_{low}^*$ due to the additional positive term at the left-hand side of (21) and the fact that the left-hand (right-hand) side of (21) monotonically decreases (increases) in \hat{a}_{low}^* .²⁷

In the *high-treatment*, worker i maximizes

$$\frac{w_H + w_L}{2} p(a_i) p(a_j) - c(a_i) - D(w_L + w_H, 1 - p(a_i) p(a_j)).$$

By using the first-order condition

$$\frac{w_H + w_L}{2} p(a_j) + D_2(w_L + w_H, 1 - p(a_i) p(a_j)) p(a_j) = h(a_i), \quad (22)$$

the symmetric equilibrium $(a_i, a_j) = (\hat{a}_{high}^*, \hat{a}_{high}^*)$ can be characterized via

$$\frac{w_H + w_L}{2} p(\hat{a}_{high}^*) + D_2(w_L + w_H, 1 - p(\hat{a}_{high}^*)^2) p(\hat{a}_{high}^*) = h(\hat{a}_{high}^*). \quad (23)$$

²⁷Recall that $D_{22} \geq 0$.

Comparing (11) and (23) shows that $\hat{a}_{high}^* > a_{high}^*$: (11) can be rewritten as

$$\frac{w_H + w_L}{2} = \frac{h(a_{high}^*)}{p(a_{high}^*)} \quad (24)$$

with the right-hand side being monotonically increasing in a_{high}^* due to (1). Rewriting (23) yields

$$\frac{w_H + w_L}{2} + D_2(w_L + w_H, 1 - p(\hat{a}_{high}^*))^2 = \frac{h(\hat{a}_{high}^*)}{p(\hat{a}_{high}^*)}, \quad (25)$$

with the left-hand side being monotonically decreasing in \hat{a}_{high}^* because of $D_{22} \geq 0$, whereas the right-hand side monotonically increases in \hat{a}_{high}^* due to (1). Since the left-hand side of equation (25) differs from the left-hand side of (24) by the positive term $D_2(w_L + w_H, 1 - p(\hat{a}_{high}^*))^2$ the relation $\hat{a}_{high}^* > a_{high}^*$ must be true.

When comparing the three equilibrium efforts under disutility of bankruptcy for our setting with a zero loser prize, we immediately obtain $\hat{a}_{low}^* > \hat{a}_{no}^*$. Equilibrium efforts in the no-treatment are still larger than in the high-treatment if standard monetary incentives have a higher impact on the subjects' effort choices than the disutility of bankruptcy. This can be seen by inspection of the left-hand sides of (3) and (23) with $w_L = 0$:

$$D_2(w_H, 1 - p(\hat{a}_{high}^*))^2 p(\hat{a}_{high}^*) < (1 - p(\hat{a}_{high}^*)) \frac{w_H}{2}. \quad (26)$$

Since direct monetary income should be more relevant for a subject than second-order feelings of uncomfortableness due to possible bankruptcy, it seems plausible that the inequality is satisfied, implying $\hat{a}_{no}^* > \hat{a}_{high}^*$.

The findings of our experiment emphasize that subjects' average effort exceeded the respective equilibrium effort of the basic model considerably more in the high-treatment than in the low-treatment. This major puzzle can be explained by the disutility of bankruptcy, if the introduction of $D(w_H, P)$ in the players' objective functions shifts efforts more upwards in the high-treatment than in the low-treatment. The comparison of (21) and (23) indicates that disutility of bankruptcy has higher impact in the high-treatment than in the low-treatment if

$$D_2(w_H, 1 - p(\hat{a}_{high}^*))^2 p(\hat{a}_{high}^*) > D_2(w_H, (1 - p(\hat{a}_{low}^*))^2) (1 - p(\hat{a}_{low}^*)).$$

Since realized values of $p(a_i) = a_i$ were typically higher than 0.5 in all treatments and subjects chose higher efforts in the low-treatment than in the high-treatment, we have $p(\hat{a}_{high}^*) > (1 - p(\hat{a}_{low}^*))$. Moreover, higher effort levels in the low-treatment than in the high-treatment lead to $D_2(w_H, 1 - p(\hat{a}_{high}^*))^2 \geq D_2(w_H, (1 - p(\hat{a}_{low}^*))^2)$ because

$D_{22} \geq 0$, and

$$1 - p(\hat{a}_{high}^*)^2 > (1 - p(\hat{a}_{low}^*))^2 \Leftrightarrow 2p(\hat{a}_{low}^*) > p(\hat{a}_{low}^*)^2 + p(\hat{a}_{high}^*)^2$$

is true for $\hat{a}_{low}^* > \hat{a}_{high}^*$.

Note that larger extra incentives due to bankruptcy in the high-treatment than in the low-treatment do not crucially depend on $\hat{a}_{low}^* > \hat{a}_{high}^*$ but on the generally high effort levels in the two bankruptcy treatments. In fact, recall that the probabilities of bankruptcy are differently formed in both treatments. In the low-treatment, we have $P = (1 - p(a_i))(1 - p(a_j))$. Differentiating with respect to a_i gives

$$\frac{\partial P}{\partial a_i} = -p'(a_i)(1 - p(a_j)).$$

Thus, if in the low-treatment co-worker j already chooses considerable effort, worker i 's impact on the reduction of P and, therefore, on reducing his disutility of bankruptcy will be rather low. This effect decreases worker i 's incentives to avoid bankruptcy. This argumentation holds for both workers and explains the rather limited effect of bankruptcy on extra incentives in the low-treatment. Technically, this effect can be best seen from the last term at the left-hand side of the first-order condition (20), $1 - p(a_j)$, which is rather small for high values of a_j . However, in the high-treatment we have just the opposite effect. Here, the probability of bankruptcy reads as $P = 1 - p(a_i)p(a_j)$ with

$$\frac{\partial P}{\partial a_i} = -p'(a_i)p(a_j).$$

Hence, in the high-treatment worker i 's impact on the reduction of the bankruptcy probability increases in co-worker j 's effort level a_j . Consequently, under high chosen efforts and high effort beliefs in the two bankruptcy treatments (see Figures 2 and 4) workers have strong incentives to exert effort in order to reduce their disutility of bankruptcy in the high-treatment. This effect is shown by the last term at the left-hand side of the first-order condition (22), $p(a_j)$, which is rather large given a high value of a_j .

In order to exemplarily illustrate individual behavior under disutility of bankruptcy, let

$$D(w_L + w_H, P) = \alpha \cdot (w_L + w_H) + \beta \cdot P, \quad \alpha, \beta \in (0, 1)$$

with the two weights α and β measuring the workers' degree of bankruptcy aversion for the two dimensions "monetary income" and "bankruptcy risk".²⁸ Together with our

²⁸ α and β being smaller than one indicates that monetary incomes are more important for individuals than negative feelings from a possible loss of incomes.

parameterized functions in the experiment described by (17) and $w_L = 0$ we obtain

$$\hat{a}_{low}^* = \frac{1}{800} \left(\sqrt{(2\beta + w_H)^2 + 3200(\beta + w_H) - w_H - 2\beta} \right)$$

and $\hat{a}_{high}^* = \frac{1}{200} \left(\frac{w_H}{2} + \beta \right)$

as equilibrium effort levels, which both lie in the interval $(0, 1)$ in the given setting with $w_H = 100$. Moreover, it is easy to check that $\hat{a}_{low}^* > \hat{a}_{no}^* > \hat{a}_{high}^*$ holds. We finally have to show that disutility of bankruptcy increases equilibrium efforts more strongly in the high-treatment than in the low-treatment, that is

$$\hat{a}_{high}^* - a_{high}^* > \hat{a}_{low}^* - a_{low}^* \tag{27}$$

with $a_{high}^* = 0.25$ and $a_{low}^* = (\sqrt{33} - 1) / 8 \approx 0.6$. Inserting for the equilibrium efforts and $w_H = 100$ in condition (27) and rearranging yields $4\beta (2\beta + 75\sqrt{33} - 225) > 0$, which is clearly satisfied. Hence, in our example we can explicitly show that extra incentives due to bankruptcy aversion are stronger under high bankruptcy risk than under low risk of bankruptcy.

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