Disclosure Policy in Contests with Sabotage and Group Size Uncertainty

Jonathan Stäbler*

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Abstract

In many contests, players are not aware of how many competitors they face. While existing studies examine how disclosing this number affects their productive effort, this paper is the first to consider its impact on destructive behavior. For doing so, I theoretically and experimentally study how revealing the number of contestants affects both effort and sabotage compared to concealing this information. Further, I evaluate the created value by comparing the resulting performances, which are shaped by the combination of the exerted effort and the received sabotage. I show that the overall performance can be higher under concealment, even though the disclosure policy does not affect average effort and sabotage levels. The experimental results largely confirm these theoretical predictions and demonstrate the significance of accounting for the effects of sabotage, as it induces performance differences between the group size disclosure policies. By concealing the number of contestants, a designer can mitigate the welfare-destroying effects of sabotage, without curbing the provision of value-creating effort.

Keywords: Sabotage, Contests, Group Size Uncertainty, Group Size Disclosure, Experiment[1]

JEL: C72, C91, D62, D74, D82

*Department of Economics, University of Mannheim, L7 3-5, 68131 Mannheim, Germany. e-mail: jstaeble@mail.uni-mannheim.de

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1 Introduction

Contests exist in many settings, including job promotion tournaments, crowdsourcing contests, academic research grant applications, and procurement auctions. In these competitive situations, agents spend non-refundable resources to outperform one or more competitors to enhance their chances of winning a valuable prize. However, in many cases, agents are not aware of how many other contestants they are facing, and whether there is another competitor at all (e.g., Boosey et al. 2017, Morgan et al. 2012, Lim & Matros 2009). In those cases, a contest designer, seeking to increase value-creating effort provisions, may decide to disclose the number of contestants or leave uncertainty about the group size. For instance, in a workplace setting, a manager may decide to reveal the number of short-listed candidates being considered for promotion. Similarly, when companies or the government offer inducement prizes for innovations or conduct procurement auctions, they may choose to disclose the number of participating competitors.[2]

While for contest designers, disclosing the number of participants is an easy-to-implement tool, for contestants, this decision can have implications for their effort levels. That is because winning chances are determined by contestants' performances *relative* to the performances of their competitors. Relative performances are shaped by each contestant's effort level and, thus, deciding how much effort to exert depends on the number of competitors and beliefs about their effort levels. In line with theoretical equilibrium predictions, the experimental literature shows that if contestants know how many other contestants there are, effort usually decreases with an increasing group size (Dechenaux et al. 2015). If they do not know this number, it becomes more difficult to determine how much effort is needed for outperforming others. In such cases, the theoretical equilibrium decisions are a weighted sum of the equilibrium choices conditional on the group sizes (Lim & Matros 2009), which lead to no difference in the average effort levels between disclosing and concealing the number of contestants (Fu et al. 2016, 2011). In these standard settings, even though effort choices become more difficult when players do not know the number of competitors, the experimental literature is consistent with theory as it does not find significant differences between the two disclosure policies (Jiao et al. 2022, Boosey et al. 2020, Aycinena & Rentschler 2019).

Yet, the choice of the disclosure policy may not only influence contestants' constructive efforts, but also induce destructive behavior such as sabotage. Along with effort, sabotage is another strategy to increase one's relative performance – not through own productive effort but by negatively distorting one's competitors' performances, and a substantial literature has emerged on this topic (e.g. Chowdhury et al. 2023, Dato & Nieken 2020, Chowdhury & Gürtler 2015, Charness et al. 2014, Gürtler et al. 2013, Harbring & Irlenbusch 2011, Carpenter et al. 2010, Lazear 1989). Such sabotage can take various different forms. For instance, in workplace promotion tournaments, co-workers may withhold important information, skills, or

[2]See (Fu et al. 2016) for a more detailed discussion of these examples.

experiences, share only partial information, or even provide wrong information to reduce the productivity of their colleagues (e.g., Serenko 2020, Pan et al. 2018, Kumar Jha & Varkkey 2018, Evans et al. 2015, Ford & Staples 2010). Sabotage can also occur between companies, for instance through cyberattacks on the information and production systems of potential competitors. Bitkom (2018) estimated that in Germany alone in the year 2017 and 2018 more than ten billion Euros were lost because of cyberattacks, including cyberattacks as a form of sabotage between competing companies. If such destructive behavior happens, effort is spent less productively, which results in a decrease of the overall created value. For instance, sabotaged co-workers may work with less efficient tools and focus on less important tasks, or companies have to spend their resources to fix the created damages.[3]

Although sabotage is of such importance for welfare, we still do not know how the choice of a group size disclosure policy affects sabotage behavior. Yet, a policy that aims to increase welfare should take the adverse effects of sabotage into account. In this paper, I address this research gap by theoretically modelling and experimentally testing the differences between concealing and disclosing the number of contestants, taking into account not only contestants' effort choices but their sabotage decisions, as well. I first analyze the comparative statics of the realized group sizes under disclosure and the comparative statics of different enter probabilities and number of potential contestants under concealment. Then, I compare the resulting efforts and sabotage levels, expected payoffs, and performances between the disclosure policies. As a welfare measure, I focus on the sum of individual performances (*group performance*), as it shows the overall created value in the presence of sabotage-induced value losses.

In my theoretical analysis, I follow Konrad (2000) to model sabotage in a Tullock contest (Tullock 1980) and employ exogenous enter probabilities to model group size uncertainty, following Lim & Matros (2009). I introduce a designer, who commits to always conceal or disclose the number of contestants, however not their identities,[4] following Fu et al. (2011). The theoretical results show that average effort and sabotage levels, as well as expected payoffs are not different between the disclosure policies. There are however differences in the produced value. Specifically, I show that the average group performance is higher under concealment.[5] Group performance represents the created value and increases in own effort levels, and decreases in the received sabotage, with decreasing marginal returns. When contestants know the number of participating competitors, they can adjust their effort and sabotage levels to this information, while they cannot adjust them when the group size is concealed. Consequently, the distribution of effort and sabotage differs across group sizes, inducing differences in performances between the disclosure policies.

[3]Other common sabotage examples include the denigration of potential competitors' products or services (Nissen & Haugsted 2020), negative campaigning in political races (Lau & Rovner 2009), or fouls in sports (Deutscher et al. 2013). In this paper, I focus on sabotage that is used to decrease the productivity of competitors and thus destroys value.

[4]When subjects do not know the identities of the entered contestants, they sabotage everyone that potentially enters under both disclosure policies.

[5]If a designer also revealed contestants' identities, this difference would be even more pronounced.

The highest performance difference occurs in the case when there is only one contestant, who will win the prize with certainty. In this case, the one contestant does not exert any effort when she knows this fact, otherwise, she takes into account also other possible group size realizations. As a consequence, the one contestant exerts a substantive amount of effort, while not receiving any sabotage, leading to a particularly high performance. For all other group size realizations, the performance differences between the disclosure policies are small, resulting in a higher average performance under concealment, when there is at least a 1 percent chance of being the only contestant.

To evaluate the validity of these theoretical predictions, I conduct an experiment[6]. As sabotage is difficult to observe in the field,[7] a laboratory experiment is an optimal environment to test theories involving the possibility of sabotage. This holds especially true for this paper's setting because it involves a complex setting with several sources of uncertainties and best responses to competitors' effort *and* sabotage levels.[8]

In the experiment, subjects play a Tullock contest with group size uncertainty, where each group member has the same exogenous enter probability. I vary the disclosure policy (concealment vs. disclosure) within subjects, and enter probabilities (0.25 vs. 0.75) and the size of the group (3 vs. 5) between subjects, leading to different probabilities of being the only contestant (0.4%, 6%, 32%, and 56%). Subjects receive an endowment that they can use to invest in 'Option A' (effort) to improve their own performance, or in 'Option B' (sabotage) to negatively affect everyone else's. Under group size disclosure, subjects make effort and sabotage decisions conditional on the realized group size via the strategy method, whereas under concealment they make one effort and one sabotage decision to fit all realized group sizes. To create the notion of value-creating effort and value-destroying sabotage in the experiment, money is donated to a non-profit charity, and the amount depends on the absolute performance of the group. Hence, by investing in effort, subjects increase both their own performance and donations, whereas by investing in sabotage, they increase their own relative performance by decreasing their opponents' performances but at the cost of decreasing donations. Importantly, the inclusion of this externality does not change the theoretical predictions, even if subjects have a preference for donations.

The experimental results are largely in line with theory and add to our understanding of contestants' behavior under the two disclosure policies. The first key finding is that group performance is significantly higher under concealment compared to disclosure but only when the probability of being the only contes-

[6] The experiment was preregistered at aspredicted.org `https://aspredicted.org/blind.php?x=VB2_4DF` and received ethical approval from the Ethics Committee of the University of Mannheim (EK Mannheim 09/2022.

[7] Observational studies usually rely on sports data to identify sabotage, which they typically define as the breaking of rules (e.g. Brown & Chowdhury 2017, Deutscher et al. 2013, Balafoutas et al. 2012, Del Corral et al. 2010).

[8] As a consequence, behavior may be influenced by other factors such as bounded rationality, probability distortions, risk aversion, and many others. Additionally, contests typically also induce non-monetary utilities such as joy of winning, which can lead to heterogeneous behavior (Dechenaux et al. 2015). With the existence of sabotage, other motives such as spitefulness may become relevant. Therefore, this experiment can be viewed as a robustness test for the theoretical predictions, which allows for these additional factors.

tant is not too low. As predicted, this difference is driven by the possibility of being the only contestant, where subjects do not receive any sabotage and exert much higher effort under concealment compared to disclosure. Consequently, there is no difference in group performance, when the probability of being alone is 0.4%, but in all other treatments where this probability is at least 6%, concealment leads to a higher group performance.

The second key finding is that there is no evidence for a difference in average sabotage and effort levels, as well as in expected payoffs between the two disclosure policies. The only exception is when the number of potential contestants is 3 and enter probabilities 0.25. In this case, concealment leads to an increase in sabotage levels. This difference to the equilibrium predictions can be explained by theoretical considerations based on regret aversion (Diecidue & Somasundaram 2017, Loomes & Sugden 1987, Bell 1982). Nonetheless, even in this case, the expected payoffs do not differ between the disclosure policies.

As additional results, I confirm the predicted comparative statics of disclosed group sizes, where a larger group size reduces sabotage and effort levels. At the same time, there is above-equilibrium sabotage in groups of size 3, 4, and 5. This behavior can be explained by joy of winning that increases in the number of competitors (constant winning aspiration) (Boosey et al. 2017), or by spiteful preferences (Morgan et al. 2003, Levine 1998). As to the comparative statics of group size uncertainty, an increase in the number of potential contestants decreases sabotage for high enter probabilities, in accordance with theory. For low enter probabilities, however, I do not find evidence for the hypothesized increase.

The contribution of this paper is as follows. I add to the discussion of group size disclosure policies, by examining contestants' behavior in a more nuanced setting, that allows not only for constructive behavior but also for destructive behavior. The literature shows that competition also induces cheating, fraud, and sabotage besides productive efforts (Piest & Schreck 2021, Chowdhury & Gürtler 2015, Carpenter et al. 2010, Faravelli et al. 2015), and thus a more realistic contest setting should account for such behavior. Moreover, the inclusion of sabotage is indispensable for policy evaluations, as sabotage destroys value and therefore has negative welfare implications. In the most standard contest setting without sabotage, the disclosure policy does not influence the average exerted effort and hence the created value (Lim & Matros 2009). I show that when sabotage in contests is accounted for, higher performances can be induced by concealing the number of competitors. This has substantial implications for contests' design. A designer can mitigate the welfare-destroying effects of sabotage by concealing the number of contestants.

I also contribute to the sabotage literature by suggesting a policy that mitigates the destructive effects of sabotage without curbing productive efforts. The theoretical and experimental literature shows ways of how to decrease sabotage altogether, including reducing the prize spread (Harbring & Irlenbusch 2011, 2005, Del Corral et al. 2010, Vandegrift & Yavas 2010, Lazear 1989), increasing the number of contestants

(Konrad 2000), increasing the penalties for sabotage (Balafoutas et al. 2012), revealing the identity of the saboteur (Harbring et al. 2007), or not revealing intermediate relative performances or rank (Charness et al. 2014, Gürtler et al. 2013, Gürtler & Münster 2010) as sabotage is directed against the most able or best performing contestant (Deutscher et al. 2013, Harbring et al. 2007, Münster 2007, Kräkel 2005, Chen 2003). For broader literature reviews on sabotage in contests see Piest & Schreck (2021), Amegashie et al. (2015) or Chowdhury & Gürtler (2015).

This paper also informs other theoretical contest settings without sabotage, where there are already differences in effort choices between the two group size disclosure policies. Accounting for the effects of sabotage may interact with their identified effects and possibly change the conclusions. These settings include different prize valuations together with different enter probabilities (Fu et al. 2016), different prize valuations with endogenous entry (Chen et al. 2023), the existence of bid caps (Wang & Liu 2023, Chen et al. 2020), either convex or concave cost structures (Jiao et al. 2022, Chen et al. 2017), and an either strictly convex or concave characteristic function of the Tullock contest (Feng & Lu 2016, Fu et al. 2011).

I further add to the experimental contest literature without sabotage (Jiao et al. 2022, Boosey et al. 2020, Aycinena & Rentschler 2019), which, in most settings, finds no difference in average effort levels between the two disclosure policies. In more specific settings, the experimental literature finds that disclosure can lead to higher effort levels, for instance when the outside option is high and entry endogenous (Boosey et al. 2020), or when effort costs are concave (Jiao et al. 2022). In this paper, I show that concealment leads to a higher performance, even though there are no differences in the average effort and sabotage levels.

By also studying the comparative statics of group size, I provide evidence for the influence of known group sizes on sabotage, which so far lacks empirical evidence as pointed out by (Piest & Schreck 2021, Chowdhury & Gürtler 2015).[9] As I find substantial oversabotage for larger group sizes, I argue that sabotage is not necessarily a 'small number phenomenon' (Konrad 2000). Therefore, increasing group size may not be an apt tool to decrease overall sabotage and should therefore be used with caution, if at all.

Moreover, my paper is the first to consider group size uncertainty in a contest with sabotage. For contests without sabotage, the literature shows that group size uncertainty matters for effort levels of contestants.[10] Yet, the existing sabotage literature assumes that the number of contestants is common knowledge.[11] I experimentally confirm that effort and sabotage decisions under uncertainty can be de-

[9] So far, there is only one experimental study that investigates a known number of competitors but in a rank-order tournament, which predicts no differences in sabotage levels across group sizes and thus the authors do not find any differences in their experiment (Harbring & Irlenbusch 2008).

[10] Gu et al. (2019), Boosey et al. (2017), Chen et al. (2017), Ryvkin & Drugov (2020), Kahana & Klunover (2016, 2015), Morgan et al. (2012), Fu et al. (2011), Lim & Matros (2009), Münster (2006), Myerson & Wärneryd (2006), Higgins et al. (1988)

[11] Chowdhury et al. (2023, 2022), Dato & Nieken (2020, 2014), Benistant & Villeval (2019), Brown & Chowdhury (2017), Leibbrandt et al. (2017), Charness et al. (2014), Deutscher et al. (2013), Gürtler et al. (2013), Amegashie (2012), Balafoutas et al. (2012), Harbring & Irlenbusch (2011), Carpenter et al. (2010), Vandegrift & Yavas (2010), Gürtler & Münster (2010),

scribed by a weighted sum of the level choices for the known group sizes.

The structure of this paper is as follows: In section 2, I set up a theoretical model in order to derive equilibrium predictions. Section 3 shows the experimental design. In section 4, I present the results before I provide a discussion and conclusion in section 5.

2 Theoretical Model and Predictions

In this section, I introduce the theoretical model, which guides the experimental analysis. I also shortly introduce the experimental setting and derive hypotheses.[12]

2.1 Setup

I follow Konrad (2000) to model sabotage in a Tullock contest (Tullock 1980) and employ exogenous enter probabilities to model group size uncertainty, following Lim & Matros (2009).[13]

Let N be the set of all homogenous and risk-neutral potential contestants, and n the number of potential contestants indexed by $i \in N, N = \{1, ..., n\}$. Every potential contestant has the same enter probability of $q \in (0, 1]$. The set of potential contestants N and their enter probabilities q are common knowledge. Let N_i be the set of possible opponents of player i. Conditional on player i participating, let $M_i \subseteq N_i$ be the set of other active players except for player i in the contest. M_i is not known to the players. Let m be the number of active contestants including player i with $M = \{1, ..., m\}$ being the set of all active contestants including player i.

There is a contest designer, who ex-ante commits to always conceal or reveal the number of active contestants m.[14] She does not reveal the identities of the active players. Because of this, players can only choose to sabotage all other potential contestants N_i, because they know who potentially enters, but they do not know who actually entered. I assume that they can only sabotage all others the same amount.[15]

Active players compete for winning a single prize W. They choose to spend effort $e_i \geq 0$ with linear costs $C(e_i) = e_i$ and sabotage $s_i \geq 0$ with linear sabotage costs $C(s_i) = s_i$.[16] Contestant i is subjected to

Harbring & Irlenbusch (2008), Münster (2007), Harbring et al. (2007), Kräkel (2005), Chen (2003), Konrad (2000), Lazear (1989)

[12] The hypotheses are pre-registered on `https://aspredicted.org/VB2_4DF`

[13] Exogenous enter probabilities may arise when a contest is exposed to specific regulations and entry barriers, that include certain quality and safety standards of a product in a patent race, specific requirements concerning skills and characteristics of employees for a promotion, or legislation designing the rules for lobbying (Boosey et al. 2017). Likewise they may arise as mixed-strategy equilibrium enter choices (Fu et al. 2015) determined by the value of the prize, entry fees, and the outside option.

[14] If the designer decides to partially disclose the number of contestants, contestants can anticipate the specific realized group sizes, where she would prefer to disclose. Lim & Matros (2009) show in a contest without sabotage, that if a designer can not credibly commit to always either conceal or disclose, she would always disclose the number of contestants. Similar dynamics would arise in this more specific setting, but is beyond the scope of this paper.

[15] Sabotaging all others the same amount would arise in equilibrium, when contestants are homogenous and could decide to individually sabotage others. As players do not know the identities of the active contestants, even under disclosure, there is no benefit in sabotaging only one other player, because it would introduce a coordination problem with the other players.

[16] Sabotage costs incorporate expected punishment costs and reputation losses for detected sabotage, possible moral

total sabotage of $\sum_{j \in M_i} s_j$. Only active players are affected by the exerted sabotage as only they exert contest-induced additional efforts.[17] The effort and sabotage levels translate into individual performance y_i as follows:

$$y_i = \frac{e_i}{1 + \sum_{j \in M_i} s_j}$$

Individual performances are increasing in contestants' own effort levels and decreasing in the total amount of received sabotage (i.e., their opponents' sabotage levels).[18] Player i's probability of winning is determined by the following contest success function:[19]

$$p_i(y_i, y_{-i}, M_i) := \begin{cases} \frac{y_i}{y_i + \sum_{j \in M_i} y_j} & \text{if } \max\{y_1, ..., y_m\} > 0 \\ \frac{1}{m} & \text{otherwise,} \end{cases}$$

With this contest success function, relative performances determine individual winning probabilities. Therefore, players have two options to increase their winning chances. They can either increase their own performance by providing additional effort or decrease their opponents' performances by sabotaging more. An essential feature of group size uncertainty is the possibility of being the only contestant. In this case, the one only active player i wins the contest with certainty independent of her effort and sabotage choices.

The timing of the game is as follows. Before the contest, the designer ex-ante commits to always conceal or disclose the number of contestants. Then, nature determines who becomes active and enters the contest. Conditional on participating, active contestants simultaneously make their effort and sabotage choices. Afterwards, the contest is resolved according to the winning probabilities.

2.2 Experimental Conditions

Figure 1 shows an overview of the experimental conditions. I exogenously vary the number of potential contestants from $n = 3$ to $n = 5$ and enter probabilities from $q = 0.25$ to $q = 0.75$ between subjects, resulting in the treatments $3L$, $5L$, $3H$, and $5H$ with different probabilities of being the only contestant (56%, 32%, 6%, and 0.4%). At the same time, I vary the disclosure policy within subjects, hence every

costs, costs for hiding the exerted sabotage, and possible long-run costs, for example, when sabotage decreases the future productivity of agents.

[17]This assumption isolates the effect of the disclosure policy on the contest-induced performances. Additionally, if the sabotage is specifically directed towards only contest-related efforts, such as withholding information about promotion-relevant work activities, there is no effect on non-active players. Even if there is an effect on the base productivity of non-active players, and this base productivity is small enough or the effectiveness of sabotage on this base productivity is small, the results remain the same. See section 5 for a more detailed discussion.

[18]The results extend to performance functions with less pronounced marginal returns in the received sabotage: $y_i = \frac{e_i}{(1+\sum_{j \in M_i} s_j)^t}$ with $t < 1$. For $\lim_{t \to 0}$, however, sabotage does not have any effect anymore and the performance differences between the disclosure policies disappear. See appendix A.6 for a more detailed analysis.

[19]For an axiomatization see Skaperdas (1996).

subject makes decisions both under group size disclosure and group size concealment. See section 3 for the full description of the experiment.

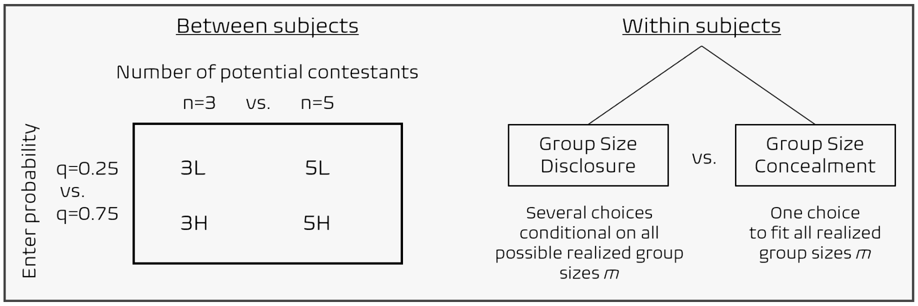

Figure 1: Experimental conditions

2.3 Group Size Disclosure

Under group size disclosure, the designer ex-ante commits to reveal the number of contestants, however not their identities. Therefore, players do not know who exactly are their competitors, but they know the number of active contestants and the set of all other potential contestants N_i. As a consequence, they can sabotage all other potential contestants, which includes their actual competitors. The decision how much effort and sabotage to exert is therefore based on their strategic response to the number of competitors and their effort and sabotage levels. Conditional on being active, player i chooses e_i and s_i to maximize her expected payoff:

$$\arg\max_{e_i,s_i} p_i(y_i, y_{-i}, m)W - e_i - s_i \tag{1}$$

The associated first-order and second-order conditions can be found in Appendix A.1. Conditional on being active, all contestants simultaneously choose effort and sabotage. The following proposition characterizes the static symmetric equilibrium:

Proposition 1. *Consider a contest as described above. The static symmetric equilibrium is characterized as follows:*

$$e^* = \frac{(m-1)}{m^2}W \tag{2}$$

$$s^* = \begin{cases} \frac{1}{m^2}W - \frac{1}{m-1} & \textit{if } W \geq \frac{m^2}{(m-1)} \textit{ and } m \geq 2 \\ 0 & \textit{else} \end{cases} \tag{3}$$

Proof. See Appendix A.2 □

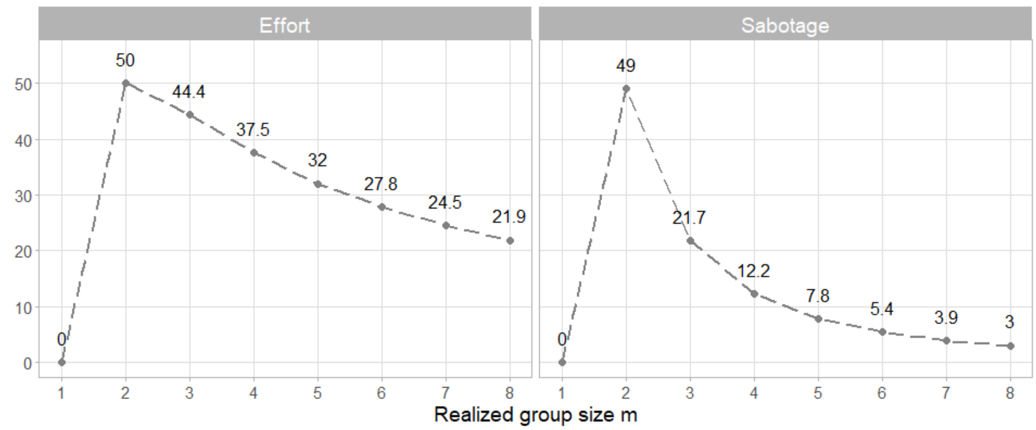

Figure 2: Static symmetric equilibrium levels for individual effort and sabotage conditional on the realized group size m for a prize of $W = 200$

Figure 2 shows the static symmetric equilibrium for effort and sabotage levels depending on the realized group size m. It includes the case, when there is no other competitor ($m = 1$). In this case, the one active player wins the prize with certainty, making it optimal to not exert any effort or sabotage. When there is at least one other contestant ($m > 1$), equilibrium effort and sabotage levels decrease with increasing group size due to more competition. Sabotage is impacted more than effort due to the additional *dispersion effect* (Konrad 2000). Any sabotage against one player benefits all other players, and hence players can free-ride on their competitors' sabotage levels. With more opponents, these dispersion effects increase, and their own exerted sabotage becomes relatively less beneficial.[20] Following the theoretical model, I hypothesize the following:

Hypothesis 1.1. *A larger disclosed group size decreases effort and sabotage levels for $m > 1$.*

2.4 Group Size Uncertainty

Under group size uncertainty, the contest designer ex-ante commits to conceal the number of contestants. Hence, contestants do not know the number of active contestants. Instead, they know the set of all other potential contestants N_i and their enter probabilities q. With these they can compute the expected number of contestants. Because they know the identities of every potential contestant, as under group size disclosure, active players can exert sabotage against all other potential contestants. Hence, conditional on being active, player i chooses e_i and s_i as follows:

$$\arg\max_{e_i, s_i} \sum_{M_i \in \mathcal{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|} p_i(y_i, y_{-i}, M_i)W - e_i - s_i \tag{4}$$

[20] The dispersion gains also exist when all competitors are sabotaged simultaneously, as one agent still profits from the sabotage against the others.

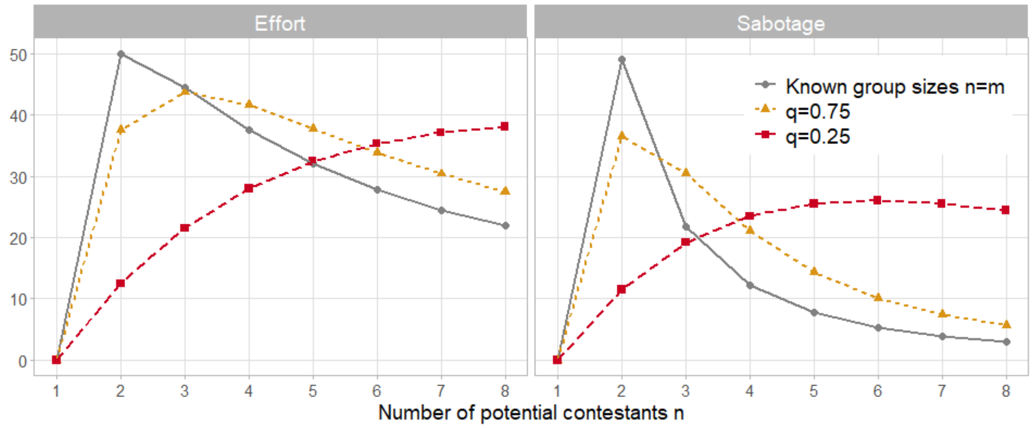

Figure 3: Individual effort and sabotage levels for uncertain group sizes for enter probabilities of 0.75 (yellow) and 0.25 (red). Additionally, it depicts the comparative statics of known group sizes (where the y-axis becomes the realized group size m). The prize is set to $W = 200$.

where $\mathcal{P}^{N_i}$ is the powerset of N_i. Conditional on participating, players simultaneously maximize their expected profit function by choosing e_i and s_i. The following proposition characterizes the static symmetric equilibrium:

Proposition 2. *Consider a contest with group size uncertainty as described above. Conditional on being active, the optimal effort in the static symmetric equilibrium is described by:*

$$e^* = \sum_{(m-1)=0}^{n-1} \underbrace{\frac{(n-1)!}{(m-1)!(n-m)!} q^{m-1}(1-q)^{n-m}}_{probability\ of\ m-1\ others} \times \underbrace{\frac{m-1}{m^2} W}_{effort\ choice\ for\ m-1\ others} \tag{5}$$

A numerical solution to the following equation describes the optimal sabotage level s^*:

$$\sum_{(m-1)=0}^{n-1} \underbrace{\frac{(n-1)!}{(m-1)!(n-m)!} q^{m-1}(1-q)^{n-m}}_{probability\ of\ m-1\ others} \times \frac{m-1}{m^2} \frac{1}{1+(m-1)s} W = 1 \tag{6}$$

Proof. See Appendix A.3 □

Proposition 2 shows that effort decisions under group size uncertainty are a weighted sum of the equilibrium choices for known realized group sizes. For sabotage, there is a numerical solution, but the choices are almost the weighted sum of the equilibrium choices for known realized group sizes.[21] Figure 3 depicts the comparative statics of group size uncertainty and shows the influence of the number of potential contestants n and their enter probabilities ($q = 0.25$ vs. $q = 0.75$) on equilibrium effort and sabotage levels. Additionally, it depicts the equilibrium choices for known group sizes to illustrate that effort and

[21] There is no closed form solution, because in the performance function, 1 is added to the received sabotage to ensure a solution in the special case of not receiving any sabotage $y_i = \frac{e_i}{1+\sum_{j\neq i} s_j}$.

sabotage choices under group size uncertainty are the weighted sum of the equilibrium choices under disclosure. As a consequence, an interesting change in the comparative statics of the potential number of contestants n arises. Specifically, when enter probabilities are high ($q = 0.75$), sabotage decreases when the number of potential contestants n increases from 3 to 5, whereas when enter probabilities are low ($q = 0.25$), sabotage increases. Hence, for the specific conditions in the experiment, I hypothesize the following:

Hypothesis 1.2. *For high enter probabilities ($q = 0.75$), effort and sabotage levels decrease when the number of potential contestants increases from $n = 3$ to $n = 5$.*

Hypothesis 1.3. *For low enter probabilities ($q = 0.25$), effort and sabotage levels increase when the number of potential contestants increases from $n = 3$ to $n = 5$.*

2.5 Comparing Disclosure Policies

In the following, I compare the effects of the disclosure policy on expected effort and sabotage levels, as well as on expected payoffs. Additionally to expected payoffs, I consider the expected sum of individual performances as a welfare measure, because it incorporates the value-creating effects of effort and the value-destroying effects of sabotage.

2.5.1 Expected Effort, Sabotage, and Payoffs

When there is uncertainty about the number of active contestants, contestants take the weighted sum of their equilibrium effort levels for the known group sizes. The expected effort is the same value, as there is only one effort choice for all realized group sizes. Under disclosure, the expected effort is the exact same weighted sum. As a consequence, there is no difference in the expected effort between disclosing and concealing the number of contestants (see appendix A.4). Moreover, a numerical analysis shows that there are also no substantial differences for sabotage levels (see appendix A.4).

Hypothesis 2.1. *There are no substantial differences in expected effort and expected sabotage levels between concealing and disclosing the number of contestants.*[22]

The expected costs are the same across disclosure policy because there is no difference in the expected effort and sabotage levels. Additionally, in the symmetry equilibrium, everyone exerts the same amount of effort and sabotage, leading to same winning probabilities independent of the realized group size and policy. Consequently, there is no difference in the expected payoffs between the disclosure policies (see appendix A.5).

[22]This hypothesis was not preregistered and was added later. However, it follows directly from the model that remained unchanged.

Hypothesis 2.2. *There is no substantial difference in expected payoffs between disclosure and concealment.*

2.5.2 Expected Group Performance

Next, to compare the created value, I study the differences in the expected sum of individual performances (group performance) between the disclosure policies. For this, I first study group performance conditional on the realized number of contestants m. Under group size disclosure, players are able to adjust their effort and sabotage levels according to the realized group size m ($e^*(m)$, $s^*(m)$). Under group size concealment, contestants cannot do this and have to choose one effort and one sabotage level for all realized group sizes ($e^*(n,q)$, $s^*(n,q)$). The equilibrium group performance conditional on the realized group size m can be described as follows:

$$P_{disclosure}(m)^* = \underbrace{\sum_{i=1}^{m} y_i(m)}_{\text{sum of individual performances}} = \underbrace{\frac{e^*(m)}{1+(m-1)s^*(m)}}_{\text{individual performance}} \times \underbrace{m}_{\text{realized number of contestants}} \tag{7}$$

$$P_{concealment}(m)^* = \underbrace{\sum_{i=1}^{m} y_i(m,n,q)}_{\text{sum of individual performances}} = \underbrace{\frac{e^*(q,n)}{1+(m-1)s^*(q,n)}}_{\text{individual performance}} \times \underbrace{m}_{\text{realized number of contestants}} \tag{8}$$

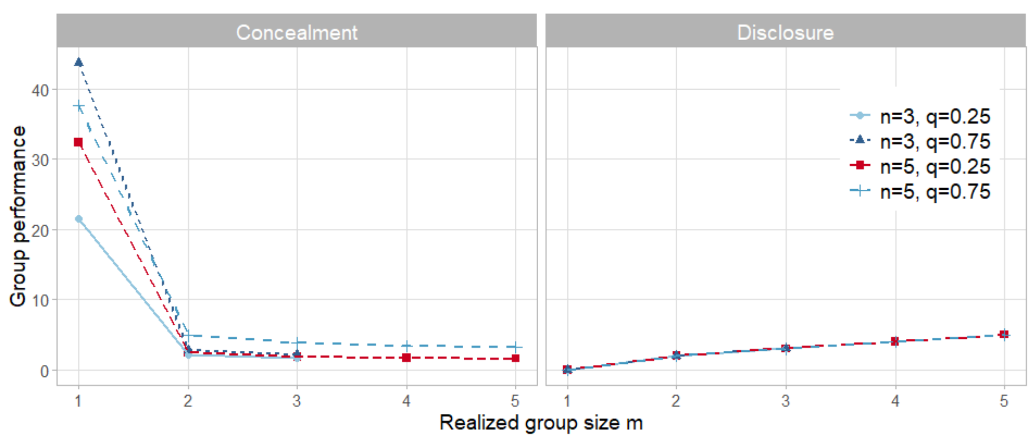

Figure 4: Group performance (sum of individual performances) conditional on the realized number of contestants under concealment (left graph) and disclosure (right graph). The different colors indicate the between treatments. Under disclosure, all four lines are exactly the same. The prize is $W = 200$.

Figure 4 depicts these equilibrium group performances, conditional on the realized number of contestants m, and the treatments (combinations of number of potential contestants n and enter probabilities q). When the number of contestants is disclosed (right panel), each individual's equilibrium performance is exactly 1 for $m > 1$. As the number of contestants m increases, the group performance increases because the individual performances are summed up. When the contestant is alone in the contest ($m = 1$), she does not exert any effort, resulting in a performance of 0.

When the number of contestants is concealed (left panel), contestants cannot adjust their effort and sabotage levels to the realized group size. Instead they choose one effort and sabotage level that is used for all realized group sizes. As a consequence, larger groups suffer from more sabotage overall, while the amount of effort stays constant. Therefore, individual performances and even the group performance fall in the group size. A special case is $m = 1$, when a player is the only contestant. In this case, she does not receive any sabotage while exerting a substantive amount of effort, leading to a particularly high performance also because of decreasing marginal returns of the received sabotage.[23] This performance is substantially higher than the performance for any other realized group size and all other performances under group size disclosure.

Next, I compare the resulting expected total group performance conditional on the number of potential contestants n and their enter probability q. The expected group performance is a weighted sum over all group size realizations and their specific group performance:

$$E[P_{Disclosure}(m)] = \sum_{m=1}^{n} \underbrace{\frac{n!}{m!(n-m)!} q^m (1-q)^{n-m}}_{\text{probability of group size } m} \times \underbrace{\frac{e^*(m)}{1+(m-1)s^*(m)} m}_{\text{group performance of } m} \tag{9}$$

$$E[P_{Concealment}(m)] = \sum_{m=1}^{n} \underbrace{\frac{n!}{m!(n-m)!} q^m (1-q)^{n-m}}_{\text{probability for group size } m} \times \underbrace{\frac{e^*(q,n)}{1+(m-1)s^*(q,n)} m}_{\text{group performance for m}} \tag{10}$$

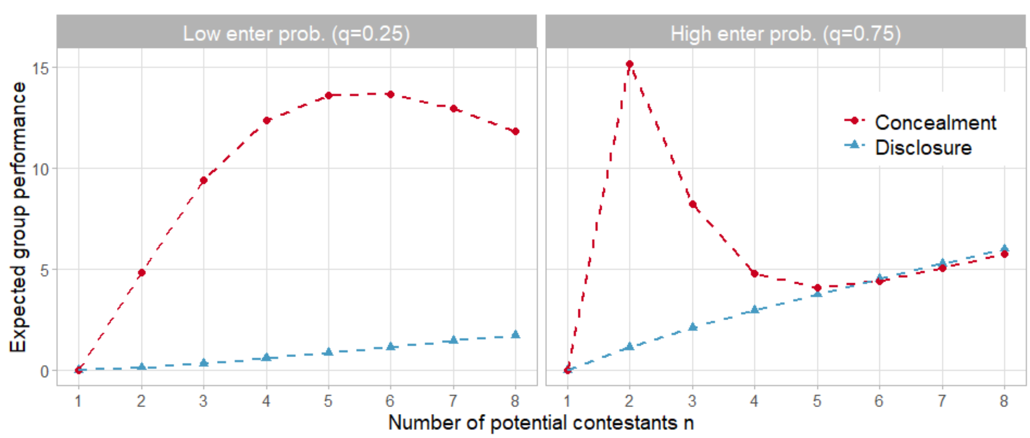

Figure 5: Expected group performance (sum of individual performances) conditional on the disclosure policy for low (left panel) and high (right panel) enter probabilities. The prize is $W = 200$.

[23] This difference is also pronounced for performance functions that have a less pronounced decrease in the marginal returns of the received sabotage (see appendix A.6). The same holds true for different values of W.

Figure 5 compares the expected group performance between the disclosure policies. It shows that when the probability of being alone is high enough, expected performances are higher under concealment compared to disclosure. When the probability of being alone ($m = 1$) gets smaller (higher n and/ or higher q), the expected group performance is roughly the same across the disclosure policies. More specifically, the performance differences become less than 1, when the probability of being the only contestants is smaller than 1%. This is because being the only contestant ($m = 1$) leads to a particularly high performance under concealment compared to zero performance under disclosure. Therefore, I hypothesize:

Hypothesis 3.1. *Concealing the number of contestants increases the expected group performance compared to disclosure when the probability of being the only contestant is not too low (at least 6%, treatments 3L, 5L, 3H).*

Hypothesis 3.2. *For a low enough probability of being the only contestant (0.4%, treatment 5H), there is no substantial difference in the expected group performance between disclosure and concealment.*

3 Experimental Design

In this section, I describe the experimental design.[24] Following the model in section 2, the main part of the experiment consists of a Tullock contest with exogenous enter probabilities. Subjects are part of a fixed group of potential contestants with size n and each of them becomes active with the same enter probability q. The value of the prize is worth EUR 18, so the contest is highly incentivized.

I exogenously vary the disclosure policy within subjects (full disclosure of the number of contestants m vs. full concealment), meaning that every subject makes decisions under both disclosure policies. At the same time, I vary the enter probability (low $q = 0.25$ vs. high $q = 0.75$) and number of potential contestants (small $n = 3$ vs. large $n = 5$) between subjects to study both disclosure rules under different scenarios. In this way, I vary the probability of being the only active contestant ($\mathbb{P}[m = 1] \in \{0.004, 0.06, 0.32, 0.56\}$) and also study the comparative statics of group size uncertainty. Lastly, under group size disclosure, subjects make several decisions conditional on all possible realized group sizes m, which allows me to study the comparative statics of different known group sizes m. For an overview of the experimental conditions see figure 1.

The main part of the experiment consists of 35 rounds of the contest. To ensure incentive-compatibility of each single round, I pay the average of 3 randomly determined rounds only.[25] These randomly chosen payments are displayed on the last page of the experiment only. Depending on the treatment, participants

[24]The experiment received ethical approval from the Ethics Committee of the University of Mannheim.

[25]See Azrieli et al. (2018) for a theoretical discussion on incentive compatibility. I decided to pay the average of three rounds instead of one single round, to contribute to the maintenance of a more reliable subject pool. Empirically, I do not observe any last-rounds effects.

are assigned to a corresponding fixed group of 3 or 5. They stay in that group until the end of the main part and only interact with other participants of this group. Therefore, I can treat each group as a statistically independent observation. Additionally, the provided feedback of the other group members is not tied to their identities, but is presented anonymously in a randomized order to reduce dynamic effects such as retaliation, reputation building, and tacit collusion across rounds.

To reduce experimenter demand and priming effects, the instructions are held on an abstract level, without using the words 'effort', 'sabotage', 'contest', or 'opponents'. Instead I call effort 'Option A' and sabotage 'Option B'. Without this framing, both choices are simply tools to increase own winning probabilities with different marginal returns. Therefore, to capture the value-creating effects of effort and the value-destroying effects of sabotage, I incentivize the resulting sum of individual performances (group performance), which is positively affected by effort and negatively by sabotage. Specifically, to incorporate these externalities on the group performance, I include donations to a charity that depend on the group performance.[26] In this way, when players exert effort, they increase their winning probabilities and the donations, and when they exert sabotage, they increase their winning probabilities but at the additional cost of decreasing the donations.[27] Note that the equilibrium predictions are not influenced by the inclusion of donations, as they do not influence the individual payoffs. Additionally, even if contestants have a preference for donations, effort and sabotage levels are only marginally different, and the comparative statics remain unchanged (see appendix A.7).[28]

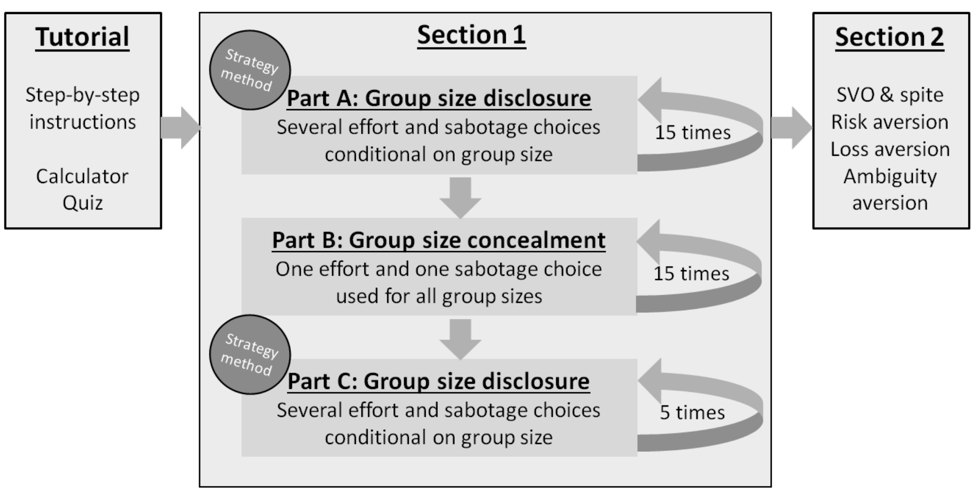

Figure 6: Experimental design

[26]Former experimental literature on sabotage in contests include a principal in their experiment whose payoff is determined by the performance of the contestants (Harbring & Irlenbusch 2011, 2008). While this procedure requires an additional participant per group, the same goal can be achieved by including donations to a charity.

[27]The donations are calculated as follows: $donations = \sum_{i=1}^{m} y_i + 10$, where m is the number of all active players and y_i the individual performance of player $i \in M$.

[28]To eliminate heterogeneous preferences for specific charities across participants, I include five charities from various sectors (Amnesty International, Doctors Without Borders, German Red Cross, Greenpeace, and UNICEF). After all sessions were conducted, one of the charities was randomly selected for all groups. Subjects were instructed about the random selection of one charity.

Figure 6 depicts an overview of the experimental design. The experiment starts with an extensive Tutorial and is followed by section 1. Section 1 contains the main part of the experiment, where part A is designed to study decisions under group size disclosure and the comparative statics about the influence of a known realized group size m. Part B is designed to study decisions under group size concealment and the comparative statics of the influence of the number of potential contestants n and their enter probabilities q. Part C is identical to part A. By comparing the choices of part B to the choices of part A and C, I compare the effects of the disclosure policies. Part A is repeated 15 times, followed by 15 repetitions of part B, followed by 5 rounds of part C. The reason why I repeat another 5 rounds of group size disclosure in part C is to control for potential order effects.[29] In section 2, I elicit social value orientation (SVO), spiteful preferences, risk, loss, and ambiguity aversion, and standard demographics.

I now describe the experimental procedure in detail. To make sure that participants understood the experiment, they started with an extensive tutorial. In this tutorial, the rules were explained carefully and subjects could make practice choices with the computer making random choices for their opponents. The tutorial started with a simple contest scenario and successively added layers to facilitate understanding. At the end of the tutorial, participants had to answer comprehension questions to ensure understanding and could only proceed until they answered all of them correctly. During the tutorial and throughout section 1, participants had access to a probability calculator, where they could try out different effort and sabotage levels (see figure 22 in appendix B).[30] As the contest's prize was EUR 18, participants had high incentives to work through the Tutorial thoroughly and were given many tools to understand the game properly.

After the tutorial, participants started with part A. Figure 7 depicts the elicitation procedure of part A. In each round of part A, subjects received an endowment of 200 points[31] and could use this to invest in effort ('Option A') and sabotage ('Option B').[32] They were asked for their choices for all possible realized group sizes prior to their realization.

After all group members made their choices, the contest was realized as follows (see figure 8): First, the computer decided who became active according to the enter probabilities.[33] After that, the computer

[29] Appendix C.1.2 shows as small negative time trend over all rounds. The results, however, are not impacted by the time trend. Specifically, the impact of the disclosure policy is very similar between the change from disclosure to concealment in round 16 and from concealment to disclosure in round 31. Additionally, the comparative statics of disclosure and concealment are not impacted by the slight time trend (see appendix C.2.2 and C.3.2).

[30] Participants could enter their own levels of effort and sabotage and do the same for all other active participants. In the simplified version, the calculator assumed all others to make the same decision. Subjects could switch to the advanced version, where they could indicate different choices for every other active participant. The probability calculator then dynamically showed them their winning probabilities for all possible group size realizations with dynamic pie charts. Additionally, the donations for the specific group sizes were shown, as well as their payoffs conditional on winning or losing.

[31] I used an experimental currency called 'points' with an exchange rate of 100 point = EUR 9.

[32] Using a chosen effort and sabotage design goes in line with (e.g. Harbring & Irlenbusch 2011, 2008) and allows me to more cleanly test the theoretical predictions. For instance, effort provision in real-effort tasks have been shown to be insensitive to monetary incentives (Erkal et al. 2018).

[33] If none of the participants were chosen to become active, the computer decided for everyone anew. This procedure does not influence the relevant group size probabilities conditional on being active.

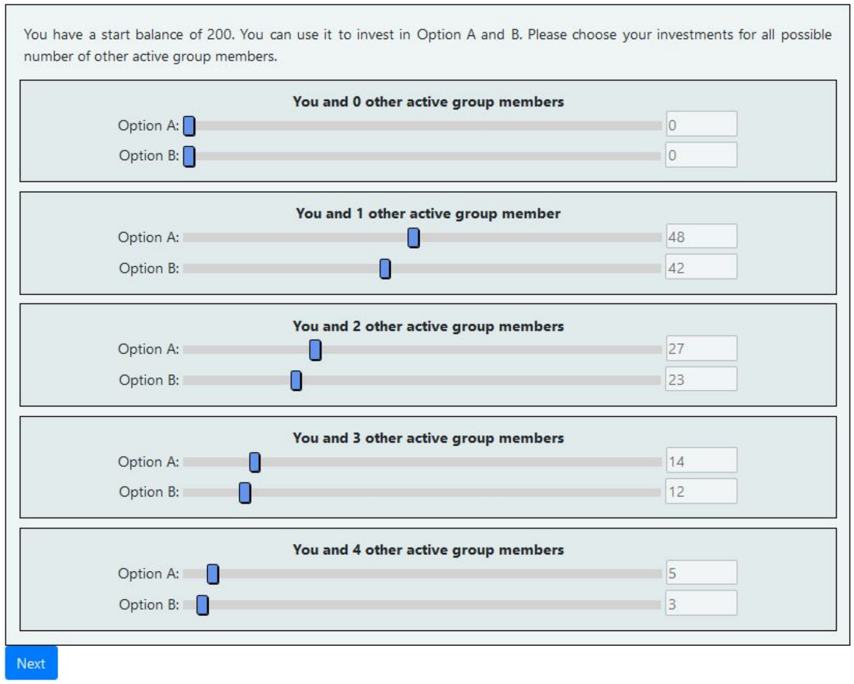

Figure 7: Effort and sabotage elicitation under group size disclosure (part A & part C)

calculated their performances and winning probabilities with the choices for the specific realized group size. It then randomly determined a winner according to the winning probabilities and calculated the donations. Then, participants received feedback about all other group members' effort and sabotage levels (including from the inactive group members) as well as the performances, winning probabilities, the winner, and the group's donations. The identities of their other group members were not disclosed in the feedback, as they were called either 'other active player' or 'other non-active player' in a randomized order.[34] Additionally, the computer calculated and showed the individual payment of the round.[35] Then the next round began.

After finishing all 15 rounds of part A, participants received short instructions for part B, and went through 15 rounds of part B. In the instructions of part B, I communicated the group size probabilities conditional on participation instead of enter probabilities for better understanding, following Boosey et al. (2017). Participants could access these probabilities throughout the whole part B (see figure 21 in appendix B). In part B, participants had to indicate one effort and one sabotage decision prior to the group size realization (see figure 9). This one decision each was then taken for any group size realization. The contest realization and the feedback were the same as in part A, with the only difference that the

[34]Including all (active and inactive) group members' effort and sabotage levels in the feedback minimizes learning effect differences between the treatments. Otherwise, as enter probabilities are different across the treatments, there would be more feedback in the 5H, 3H treatments compared to the 5L, 3L treatments. Additionally, the display of the order of the group member was randomized such that it was more difficult to identify another participant's dynamic decisions.

[35]If a player was chosen to be active, all costs for sabotage and effort were deducted from the endowment. If this active player won, the prize was added to the payment. Inactive players received the endowment and costs for the stated investments were not deducted.

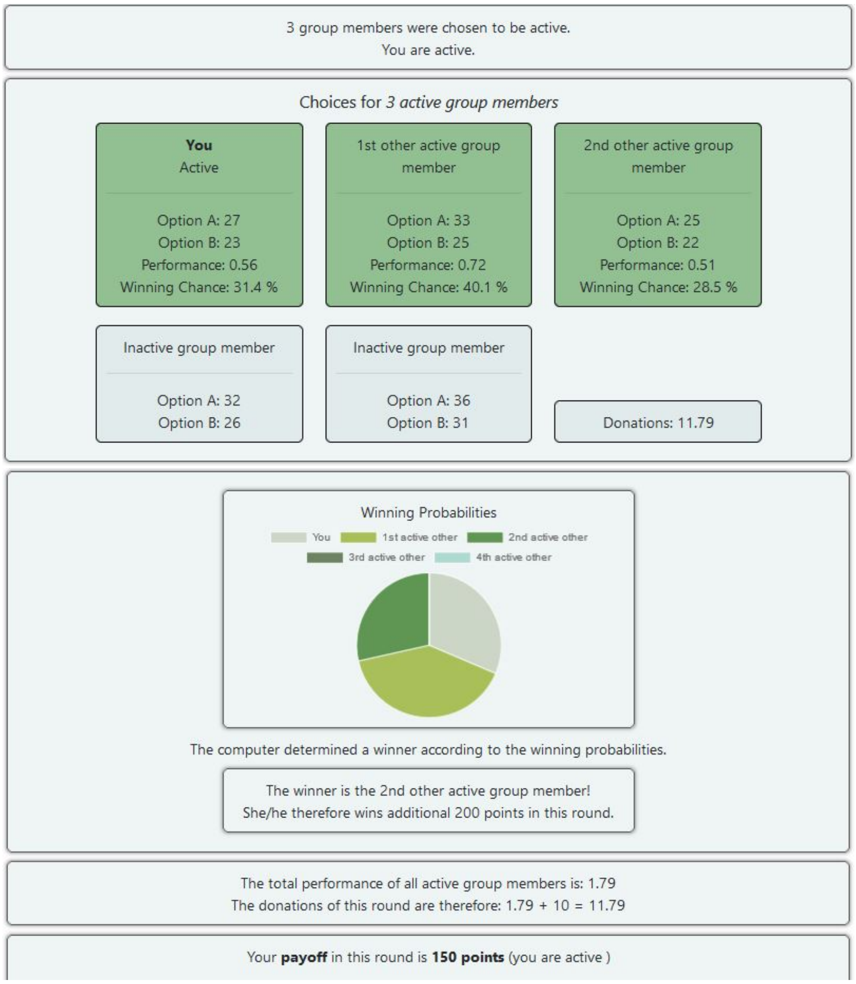

Figure 8: Contest realization and feedback after effort and sabotage elicitation

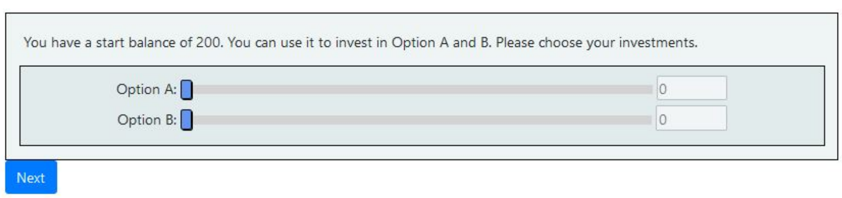

Figure 9: Effort and sabotage elicitation under group size concealment (part B).

one effort and sabotage levels were taken for any number of active contestants. After finishing part B, participants completed 5 additional rounds of group size disclosure in part C.

In section 2, I used the 6-item primary scale of the SVO Slider Task (Murphy & Ackermann 2014, Murphy et al. 2011) to elicit prosocial preferences. The choices result in a continuous measure, the SVO-angle, which ranges from $-16.26°$ to $61.39°$. It represents a participant's prosociality, where a higher angle represents a higher prosociality. I additionally included the 3 items of the spite task to elicit spiteful preferences also used by Mill & Stäbler (2023), Mill & Morgan (2022*b*,*a*), Kirchkamp & Mill (2021). The spite score is calculated by dividing the destroyed points relative to the maximally possible points and hence ranges between 0 and 1. One of the 9 items was randomly determined for payment. Afterwards, I elicited risk aversion, loss aversion and ambiguity aversion using a lottery list similar to the methods used by Holt & Laury (2002) and Sutter et al. (2013), following Boosey et al. (2017).[36] The risk and loss aversion lists were presented in a random order, ambiguity aversion was always in third place because its elicitation builds on the risk aversion list. One row of one of the lists was chosen randomly for payment. At the very end, participants answered a questionnaire to elicit standard demographics that included age, gender, highest degree, the field of study, and a self-report of how concentrated they were and how well they understood the experiment.

4 Results

In this section, I present the results of the experiment. I conducted the experiment online with the subject pool of the Mannheim Laboratory for Experimental Economics (mLab). Subjects were recruited via ORSEE (Greiner 2015) and the experiment was programmed in oTree (Chen et al. 2016). Overall, 196 subjects participated in the experiment.[37] The average duration was about 80 minutes and the average payoff EUR 21.50 (min = EUR 10.56, max = EUR 32.25). The average donations per group amounted to EUR 2.83. The mean age was 23.6 years and 50% of the subjects were female.

Throughout the results section, I rely on non-parametric Wilcoxon signed-rank tests for within-subjects comparisons and on non-parametric Mann–Whitney U tests for between-subjects comparisons. The unit of analysis is the fixed groups. As everyone makes their effort and sabotage decisions conditional on being active, but prior to knowing whether they become active or not, I analyze all effort and sabotage decisions of all the participants in each round, including those who were not chosen to become active in a specific round.

I start with the main results about the differences between the disclosure policies in section 4.1, and subsequently also show the comparative statics with respect to realized group sizes m under disclosure, and with respect to the number of potential contestants n and their enter probabilities q under group size concealment in section 4.2.

[36] In each list, participants chose between a gambling lottery and a certain amount of money. In each list, different rows represented different certainty amounts. The gamble lotteries of the risk (loss) aversion list had a 50% chance of winning (losing) 50 points and a 50% chance of 0 points. The respective certainty amounts changed between 50 (-50) and 5 (-5) points. Risk aversion and loss aversion are constructed with the row number, where participants switched between the gamble and the certain amount. In the ambiguity list, the gambling lottery also consisted of winning either 50 or 0 points. However, the probability of winning 50 points was determined by drawing a uniformly distributed variable from the range $[0\% - 100\%]$. The probability for 0 points was determined by the counter-probability. The respective certainty amounts were changing between 5 points and 50 points. Ambiguity aversion is constructed by taking the difference from the row number where participants switched in the risk list and the ambiguity list.

[37] I excluded one participant who dropped out due to internet problems, in accordance with the preregistration, which indicated the exclusion of subjects, who leave early or have continuous technical problems. Hence, I analyze the behavior of 195 subjects.

4.1 Comparing Disclosure Policies

In this section, I compare the effects of disclosing the number of contestants compared to concealment. In section 4.1.1, I find no differences in average effort, sabotage, and expected payoffs between the disclosure policies. Subsequently, in section 4.1.2, I find that the sum of individual performances (group performance) is higher under concealment, provided that the probability of being alone is at least 6%. Given that the sum of individual performances reflects the amount of value that is induced by the contest, the designer prefers concealing the number of contestants in this case.

To compare the choices of the two policies, I compute the average expected values based on the elicited values. For this, I take the weighted sum of all elicited values over all possible group size realizations (and combinations of opponents) weighted by their probabilities. In this way, I use all the elicited choices of every player in each round. As in the theory part, I do this conditional on at least one player being active. The results thus show the average expected effort, sabotage, received sabotage, payoffs, and the resulting expected group performance from a player's view conditional on being active. All results can be replicated by focusing on the actually implemented choices (see appendix C.1.5).[38]

Furthermore, there are slight time trends in the expected effort and sabotage levels, as well as in the expected group performance (see appendix C.1.2). Therefore, as robustness checks, first, I analyze only 5 rounds each around the changes of the disclosure policy (i.e., rounds 10-20 and 25-30) to focus on the induced differences.[39] Second, I run regressions that include the pre-registered controls.[40]

4.1.1 Effort, Sabotage, and Expected Payoff

Figure 10 shows the differences of the average expected effort, sabotage, and average expected payoff between the disclosure policies pooled over all treatments. As theory predicts (see hypothesis 2.1), I do not find any significant difference in the average expected effort and sabotage levels across the two disclosure policies. Even though there is a marginally significant ($p < 0.1$) increase in effort under disclosure, this difference is not robust to either focusing on the subset of rounds around the change or the regression analysis, which among other variables, controls for the time trend (see Appendix C.1.3).[41] Moreover, subjects are ex-ante indifference between the disclosure policies, as I also do not find any

[38] The realized values do not rely on all elicited values, but only on the random draw of active contestants in each round and their elicited values for the randomly realized group size and therefore add noise in each round.

[39] I did not specify this robustness check in the pre-analysis. However, it is consistent with analyzing this subset of rounds around the policy changes and controlling for time effects.

[40] The controls are: Being active in the round before, having won in the round before, average sabotage and effort levels of other participants in the rounds before, round, the treatments, realized group size in the round before, how often won in the rounds before, SVO, spite, risk, loss and ambiguity aversion, age, gender, highest degree, the field of study, the degree of concentration and understanding.

[41] Instead, the regression analysis shows a significant ($p < 0.05$) positive increase in sabotage under concealment. However, a Cohen's D of -0.09 for sabotage shows that even if there are significant differences between the disclosure policies, this difference can not be considered to be very substantive. Additionally, in no other robustness check do I find this significant increase.

significant difference in the expected individual, as predicted (see hypothesis 2.2).[42] All robustness checks do not find any significant difference (see appendix C.1.3).

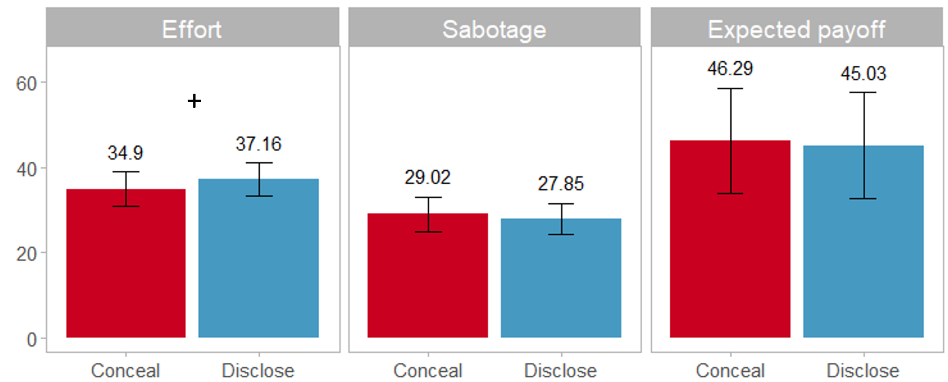

Figure 10: The figure shows average effort, sabotage, and expected payoffs conditional on the disclosure policy, pooled over all treatments. Error bars show 95% confidence intervals. Significance levels: + $p < 0.10$

The insensitivity of the exerted effort, sabotage, and the resulting expected payoffs towards the disclosure policy does not depend on the specific setting, as I do not find differences in effort, sabotage, or expected payoffs between the disclosure rules in any of the treatments individually (see appendix C.1.1). The only exception are sabotage levels in treatment *3L*, which are significantly higher under concealment ($p < 0.05$). This deviation from the theoretical prediction can be explained by considerations based on regret aversion (Diecidue & Somasundaram 2017, Loomes & Sugden 1987, Bell 1982). As the probability of being the only contestant is 52% in this treatment, subjects win the prize with certainty in many cases. Consequently, in equilibrium, they should not invest much in effort and sabotage. To avoid feeling regret of not having invested enough, however, they invest more in sabotage – which does not hurt much if they are alone and win the prize with certainty – but increases their winning chances for the other realized group sizes.[43] See appendix C.1.6 for a more formal analysis. Summarizing, I find the following:

Result 1.1. *Concealing the number of contestants does not significantly change average expected effort and sabotage levels, except when the probability of being alone is high (52%, treatment 3L), concealment leads to higher sabotage levels.*

Result 1.2. *The average expected payoff does not significantly differ between concealing and disclosing the number of contestants.*

Additionally, in the regression analysis (see appendix C.1.3), I find a significant ($p < 0.05$) negative

[42] The expected payoffs exclude the 200-point endowment in each row and thus represent the expected payoff from the contest.

[43] Effort levels are not higher under concealment. This can be due to the fact that under disclosure, effort levels are already higher even when alone.

correlation of ambiguity aversion with effort levels and a marginally significant ($p < 0.1$) correlation with sabotage. Additionally, I find a significant ($p < 0.05$) positive correlation of spiteful preferences with sabotage levels.

4.1.2 Group Performance

So far, I showed that subjects do not significantly change their average effort and sabotage levels between the disclosure policies and, as a consequence, their expected payoffs do not differ. Hence, they are ex-ante indifferent towards the chosen disclosure policy. From a welfare point of view, theory predicts that concealment leads to a higher sum of individual performances and hence to more created value. In this section, I study whether the experiment shows that group performances are indeed higher under concealment.

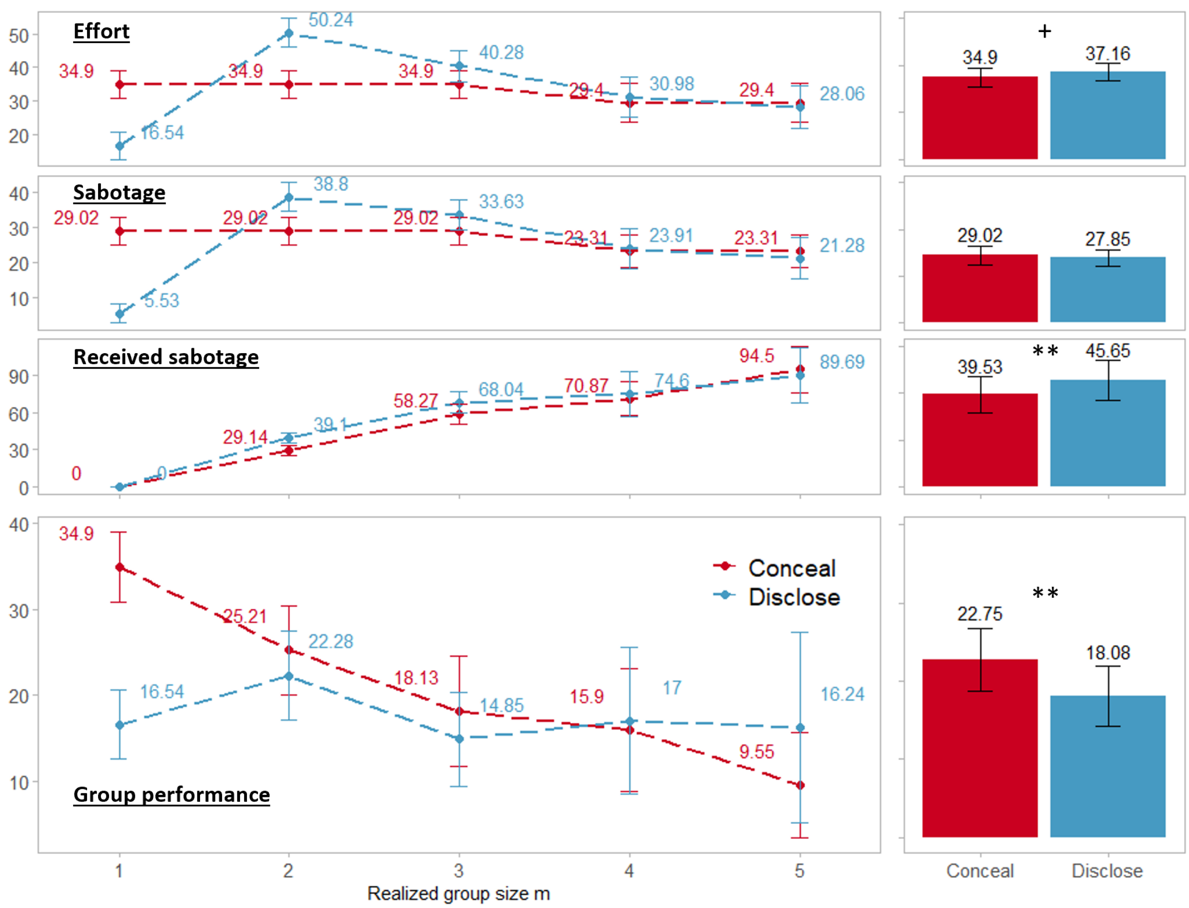

Figure 11: The right panels show differences between the two disclosure policies in the expected effort and sabotage levels, the received sabotage and for the resulting group performance. The left panels show them conditional on the realized group size. Error bars show 95% confidence intervals. Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$,

Figure 11 overall illustrates how the group performance is shaped, pooled over all treatments.[44] The

[44]The data for the realized group size of $m = 4$ and $m = 5$ come from treatments *5L* and *5H* only. Comparative statics

group performance is defined as: $\sum_{i \in M} y_i = \sum_{i \in M} \frac{e_i}{1+\sum_{j \in M_i} s_j}$, and rows 1 and 2 show the average effort and sabotage levels (e_i and s_i), row 3 the average received sabotage ($\sum_{j \in M_i} s_j$), and row 4 the average group performance. The panels on the LHS show these values depending on the realized group size, whereas the panels on the RHS show the weighted averages.

The bar chart on the RHS of row 4 shows that concealing the number of contestants significantly increases group performance ($p < 0.01$). This result can be replicated in both robustness checks ($p < 0.05$ and $p < 0.1$) (see appendix C.1.4). The panel on the LHS of row 4 depicts those differences depending on the realized group size m. It shows that the group performance difference between the disclosure policies is primarily driven by the case when contestants do not face any competitors ($m = 1$). This goes in line with theory, because under concealment, subjects have to choose one effort level without knowing the group size and hence exert a large amount of effort even if they end up being the only contestant and win the contest with certainty. If they know that they are the only contestant, they exert much less effort.[45] The important factor that induces performance differences is the combination between the exerted effort and the received sabotage depending on the realized group size. Specifically, when a contestant does not face any competitor, she is not subjected to any sabotage, simply because there are no others who sabotage her. Because of this, the substantive effort difference between the disclosure rules when alone ($m = 1$), translate directly into a large performance difference. For all other realized group sizes, contestants do receive sabotage and hence, even if there are effort differences, the resulting group performances are not very different because of the sabotage that they receive from each other. Specifically, for realized group sizes of $m = 2$ and $m = 3$, subjects exert significantly higher effort under disclosure (row 1), yet, also receive significantly higher sabotage (row 3), leading to not significantly different group performances. For realized group sizes of $m = 4$ and $m = 5$, there are no significant differences in the exerted effort, received sabotage, and resulting group performances between the disclosure policies.

Even though I find a significant difference between the disclosure policies, the difference is not as pronounced as predicted. There are two reasons for this. First, subjects on average provide a substantial amount of effort, even when they know that they are the only contestant. This is because effort is constructive and increases the donations. Second, for all other realized group sizes ($m > 2$), group performances are overall much higher than predicted under both policies (see figure 4), reducing the effect of the difference for a realized group size of one. This is because of substantial heterogeneity in the exerted effort and sabotage between subjects. The group member, who exerts the most effort, on average receives the least sabotage, and thus maintains a higher performance (see appendix C.1.7). In spite of these heterogeneities, I still find the predicted increase in group performance under concealment.

look relatively similar across treatments.

[45] They still provide non-zero effort because effort creates value and increases the donations in the experiment.

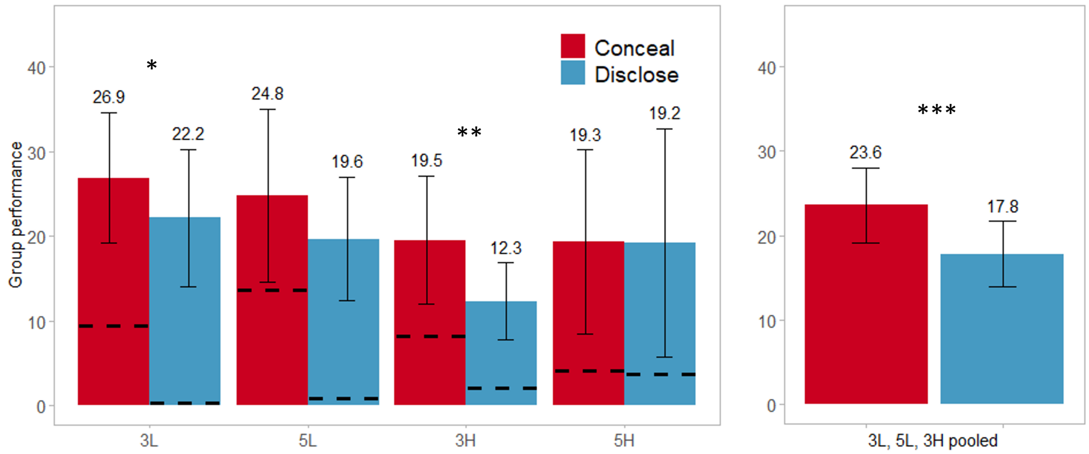

Figure 12: The bar charts show the average group performance conditional on the disclosure policy and on the treatments. Black dashed lines show the Nash equilibrium predictions. The error bars show 95% confidence intervals. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Next, I test my theoretical prediction that concealment leads to higher group performances only when the probability of being the only contestant is roughly larger than 1% (at least 6% in treatments *3L*, *5L*, and *3H* opposed to 0.4% in treatment *5H*, see hypotheses 3.1 and 3.2). Figure 12 depicts the average group performance per treatment and conditional on the disclosure policy in comparison to the Nash equilibrium predictions (dashed black lines). It shows a significant increase in the group performance under concealment for *3L* ($p < 0.05$) and for *3H* ($p < 0.01$) and a non-significant increase for *5L*. For *5H* there is no significant difference between the disclosure policies, as predicted. Moreover, because theory predicts an increase for treatments *3L*, *5L*, and *3H*, I pool them and find a significant increase in group performances under concealment ($p < 0.001$). This difference is quite substantial with an increase under concealment compared to disclosure of around 30%. The robustness checks (see appendix C.1.4) confirm the significant differences in all cases but for treatment *3H*, where I do not find any significant differences, yet the increase is qualitatively replicated.

Result 2.1. *When the probability of being alone in the contest is at least 6% (3H, 3L, 5L), concealment leads to higher group performance.*

Result 2.2. *When the probability of being alone in the contest is 0.4% (5H), I do not find any differences between the disclosure policies.*

4.2 Comparative Statics under Disclosure and Concealment

In this section, I study how different known group sizes m influence effort and sabotage levels in section 4.2.1 and how the number of potential contestants n and their enter probabilities influence effort and sabotage levels under group size uncertainty in section 4.2.2.

4.2.1 Known Group Sizes (Group Size Disclosure)

Figure 13 depicts mean effort and sabotage levels under group size disclosure conditional on the realized group size compared to the Nash equilibrium predictions. Averages are computed over all rounds (of part A and part C) and pooled over all treatments. The figure suggests that effort levels follow very closely the equilibrium predictions. Specifically, I find a significant decrease in effort from a realized group size of 2 to 5 ($p < 0.001$). This decrease in effort is in line with the experimental contest literature without sabotage (Anderson & Stafford 2003, Sheremeta 2011, Morgan et al. 2012, Aycinena & Rentschler 2019).

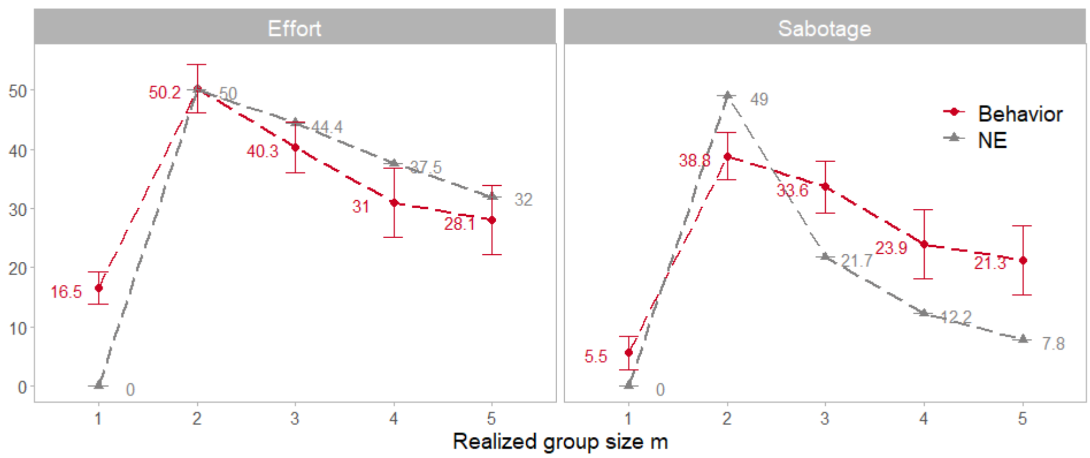

Figure 13: Mean effort and sabotage levels under group size disclosure as a function of the realized group size. Yellow lines show the equilibrium predictions. Red lines show the elicited behavior of the experiment. The error bars show 95% confidence intervals.

Furthermore, I find that sabotage also decreases significantly from $m = 2$ to $m = 5$ ($p < 0.001$), as predicted by theory (see also (Konrad 2000)). However, the decrease in sabotage is slightly less steep than predicted, leading to oversabotage for larger group sizes. In particular, sabotage levels are significantly ($p < 0.001$) below the Nash equilibrium for a group size of 2, and significantly ($p < 0.001$) above for the group sizes of 3, 4, and 5. In the experimental contest literature, it is common that subjects overinvest in effort compared to the Nash equilibrium (Sheremeta 2018, Dechenaux et al. 2015, Sheremeta 2013)[46] As the total amount of exerted sabotage is added up over the number of active contestants, this over-sabotage is particularly harmful, as it leads to more destroyed value for larger realized group sizes.

All results remain robust when analyzing different pre-registered sets of subrounds[47] and when running a regression analysis that includes the pre-registered controls (see appendix C.2.1 and C.2.4). Moreover, even though there is substantive heterogeneity in the effort and sabotage levels, the comparative statics

[46] There is no overbidding in effort and no joint overbidding, when aggregating both effort and sabotage levels. The sum of effort and sabotage levels is not significantly higher than the sum of the Nash equilibrium predictions. $m = 3$: $p = 0.078$, $m = 4 : p = 0.430$, $m = 5 : p = 0.114$

[47] The subrounds consist of only the first round, only rounds 1-7, only rounds 8-15, and only the rounds of part C. Moreover, the comparative statics remain stable over time even though there is a slight decrease in effort and sabotage over time (see appendix C.2.2).

looks relatively similar across ranks based on the sabotage levels (see appendix C.2.3). To summarize, I find the following:

Result 3.1. *An increase in the group size (for $m > 1$) decreases effort and sabotage levels.*

Result 3.2. *There are above-equilibrium sabotage levels for realized group sizes larger than* 2*.*

I propose two concepts that can explain the increases in oversabotage in the group size. First, a modified version of joy of winning – constant winning aspiration – postulates that joy of winning increases linearly with group size Boosey et al. (2017). Hence, subjects experience greater joy, when they win against more competitors, which makes them overinvest for larger group sizes. This cannot explain, however, why there exists oversabotage but not an overexertion of effort.

Second, if subjects have spiteful preferences (e.g. Levine 1998, Morgan et al. 2003), they receive additional utility for harming others. As sabotage's harm increases in the number of competitors, spite's utility gains also increase in the number of competitors and thus can explain the above-equilibrium sabotage levels for larger group sizes. Empirically, I find a positive correlation between spiteful preferences and sabotage, which suggests that spiteful preferences matter for sabotage levels (see table 9 in appendix C.2.4).

4.2.2 Group Size Uncertainty

I now turn to the case of group size uncertainty. Figure 14 depicts average effort and sabotage levels conditional on the enter probability (high vs. low) and on the number of potential contestants. For high entering probabilities ($q = 0.75$), I find a significant ($p < 0.01$) decrease in effort and sabotage levels when the number of potential contestants increases from 3 to 5, as predicted. This part of the comparative statics is therefore supported by the evidence. In the case of low enter probabilities ($q = 0.25$), however, I do not find the predicted increase in effort and sabotage levels. Instead, I find a slight (non-significant) decrease in effort and sabotage. This deviation from theory does not come from the group size uncertainty, as subjects take the weighted average of their known group size choices (see section 4.1.1). This result complements the results of Boosey et al. (2017) who find a significant increase in effort levels for an increasing group size for low entering probabilities but no significant increase for high entering probabilities.

The results remain robust to analyzing only the pre-registered subrounds and running a regression analysis with the pre-registered controls (see appendix C.3.1 and C.3.3).[48] Summarizing, I find:

[48]Specifically, I find a significant decrease (at least $p < 0.05$) in effort and sabotage levels from $3H$ to $5H$ for the subset of rounds 1-7 and rounds 8-15 and in the regression analysis. For the single round 1, I only qualitatively replicate the decrease ($p = 0.1994$). I do not find any significant differences for the treatments 3L and 5L in any of the robustness checks. Moreover, I find a slight decrease in effort and sabotage over time, however, the comparative statics remain stable (see appendix C.3.2).

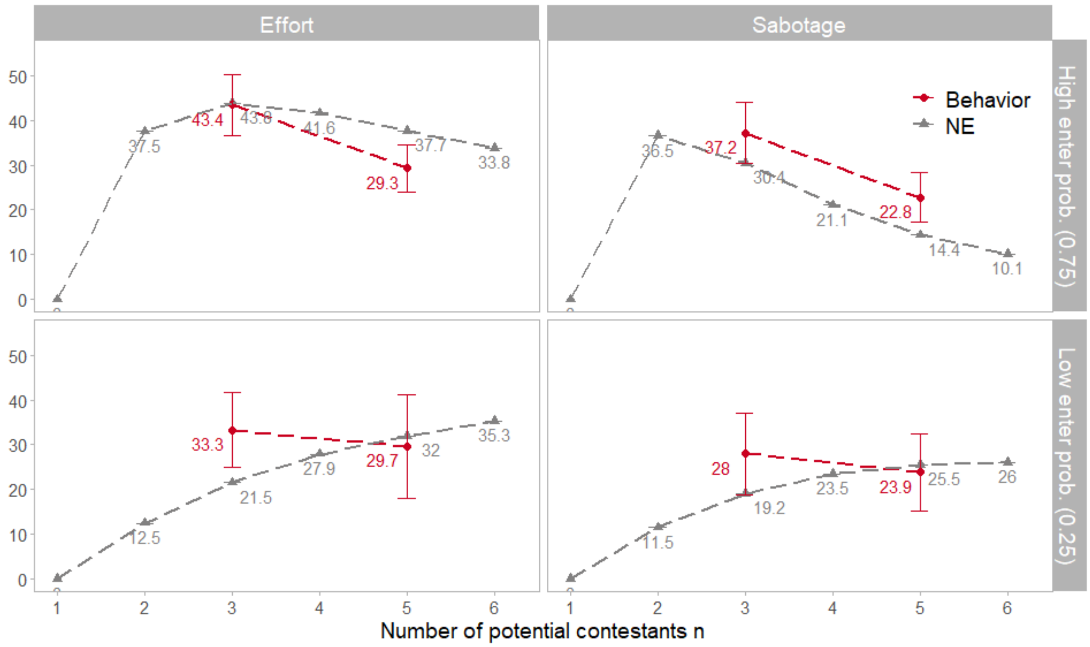

Figure 14: Mean effort (left panels) and sabotage (right panels) decisions under group size uncertainty (part B) for high (upper panels) and low (lower panels) enter probabilities. The x-axes show the number of potential contestants n. Yellow lines show the equilibrium predictions and red lines the elicited choices. Error bars show 95% confidence intervals.

Result 4.1. *For high enter probabilities ($q = 0.75$), an increase in the group size (from $n = 3$ to $n = 5$) decreases effort and sabotage levels.*

Result 4.2. *For low enter probabilities ($q = 0.25$), an increase in the group size (from $n = 3$ to $n = 5$) does not significantly change effort and sabotage levels.*

5 Discussion and Conclusion

In this paper, I provide a theoretical and experimental analysis of how disclosing the number of contestants affects effort and sabotage levels compared to concealing this information. Since contests are often used to increase the productivity of workers or companies, I compare the resulting differences in the created value. For doing so, I compare the resulting sum of individual performances (group performance), because it incorporates the productive effects of effort on own performances and the destructive effects of sabotage on others' performances.

I model sabotage in a Tullock contest with exogenous enter probabilities, where the designer commits to either always conceal or disclose the number of contestants. According to the theoretical analysis, this decision should not affect average effort, sabotage, or expected payoffs. This is because when agents do not know the number of competitors, their equilibrium levels are the weighted sum of their choices for those specific group sizes. The choice of the disclosure policy does, however, induces differences in the resulting group performance. This is because performances depend on the combination of effort and sabotage, and has decreasing marginal returns in the received sabotage. When agents do not know the realized group size, they provide one effort and one sabotage level for all realized group sizes. In contrast, when they know the realized group size, they can adjust their effort and sabotage levels to the number of contestants. As a consequence, the distribution of effort and sabotage differs between the disclosure policies depending on the realized group size and hence leads to performance differences. An essential feature of group size uncertainty is the probability of being the only contestant. When contestants know that they are alone, they do not provide any effort because they know that they will win with certainty, leading to a performance of zero. In contrast, when they do not have this information, they provide a substantial amount of effort, even when they are the only contestant. Additionally, they do not receive any sabotage in this case and hence the resulting performance is particularly pronounced. For all other realized group sizes, performance differences are relatively small between the policies, leading to a higher performance under concealment.

This result demonstrates that it is important to consider sabotage when comparing group size disclosure policies, as omitting the possibility of sabotage can lead to wrong conclusions. Indeed, in a standard contest with symmetric agents and linear costs but without sabotage, there are no differences between the disclosure policy (Lim & Matros 2009). By incorporating the welfare effects of sabotage, I show that the choice of the disclosure policy matters. This adds to other, but more specific theoretical settings, where differences between the two policies arise.[49]

I run an experiment to test my theoretical predictions. In line with theory, the first key result is that a designer can increase the sum of individual performances, and thus the amount of created value, by concealing the number of contestants. However, this only works if the probability of being the only contestant is not too low. This is because, as predicted, the difference in group performance is driven by substantially higher performances under concealment, when contestants do not face any competitors. For all other realized group sizes, I find no significant difference in the resulting group performance. Therefore, I do not find any difference in group performances, when the probability of being alone is negligible (0.4%) but otherwise (at least 6%), I find that concealment leads to higher group performances. With this result, I provide experimental evidence that from a welfare perspective the possibility of sabotage leads to differences between the disclosure policies. Consequently, the experiment can be seen as a successful robustness check to the theory by allowing for heterogeneities in prize valuations, moral costs, degrees

[49]These settings include different prize valuations together with different enter probabilities or endogenous entry (Fu et al. 2016, Chen et al. 2023), convex or concave cost structures (Jiao et al. 2022, Chen et al. 2017), a strictly convex or concave characteristic function of the Tullock contest (Feng & Lu 2016, Fu et al. 2016), or the existence of bid caps (Wang & Liu 2023, Chen et al. 2020).

of sophistication, risk aversion, probability distortion, and other heterogeneities among contestants. The experiment thus extends the generalizability of the theoretical finding.

With this first key finding, I provide evidence that sabotage matters when considering the welfare effects of a group size disclosure policy. Contrary to the experimental findings of Boosey et al. (2020) and Jiao et al. (2022), who find that concealment leads to lower effort provisions, I find that when subjects can sabotage each other, concealment leads to an increase in performance. I also add to the sabotage literature, by providing a way of how to mitigate the welfare-destroying effects of sabotage. This is different to the approach of the sabotage literature that mostly discusses ways of how to decrease sabotage altogether (see Chowdhury & Gürtler (2015)).[50]

The second key result is that contestants are ex-ante indifferent between the two disclosure policies. This is because I do not find any difference in average effort, sabotage, or expected payoffs between the disclosure policies, as predicted. The only exception is when the probability of being the only contestant is high (56%), where I find that concealment leads to an increase in sabotage. This difference can be explained by theoretical considerations based on regret aversion (Diecidue & Somasundaram 2017, Loomes & Sugden 1987, Bell 1982), where subjects would feel regret of investing too little in the cases that they are not the only contestant.

Not finding any significant difference in effort and sabotage levels between the disclosure policies, goes in line with the experimental literature, which also does not find differences in the average effort levels in contests in most settings (Jiao et al. 2022, Boosey et al. 2020, Aycinena & Rentschler 2019). However, when the outside option is high and enter choice is endogenous (Boosey et al. 2020), or when the cost structure is concave (Jiao et al. 2022), disclosing the number of contestants can induce higher efforts. I provide the special case of a high probability of being the only contestant (56%), where disclosure leads to lower sabotage, but not to a difference in effort. In all other cases, I find that under concealment, choices are the weighted sum of subjects' choices under disclosure. Consequently, subjects in my experiments do not seem to exhibit probability distortions. This is different to the experiment of Boosey et al. (2017), where the authors explain their observed effort levels under group size uncertainty with probability distortions.

The practical implication for a designer is that she can induce higher performances by concealing the number of contestants without curbing their productive efforts or expected payoffs. This is a notable result, because the created value can be increased without requiring contestants to exert additional effort. Rather, it enhances the productivity of the exerted effort by mitigating the destructive effects of potential sabotage. Furthermore, concealing the number of contestants is an easy-to implement tool because not

[50] Possible such ways include reducing the prize spread (Harbring & Irlenbusch 2011, 2005, Del Corral et al. 2010, Vandegrift & Yavas 2010, Lazear 1989), increasing the number of contestants (Konrad 2000), increasing the costs for sabotage (Balafoutas et al. 2012), and other information disclosure polices such as concealing intermediate rank information (Charness et al. 2014, Gürtler et al. 2013, Gürtler & Münster 2010), or revealing the identity of the saboteur (Harbring et al. 2007).

disclosing the number of contestants simply requires to deliberately omit information about the group size. Whether concealment should be implemented, however, depends on the specific setting. This is because concealment is effective only when the probability of a player being the only contestant is not too low (larger than 6%). At the same time, if this probability is too high (56%), concealment can lead to higher sabotage levels. A designer should therefore carefully counterbalance the effects of a specific setting.

As additional results, I find evidence for the comparative statics of known group sizes under group size disclosure. When contestants know the number of competitors, a higher group size decreases effort and sabotage levels. This provides evidence for the theoretical sabotage results of Konrad (2000), which has been pointed out to lack empirical evidence (Piest & Schreck 2021, Chowdhury & Gürtler 2015). I also observe significant above-equilibrium sabotage levels for realized group sizes of 3, 4, and 5. This behavior can be explained by a modified version of joy of winning (constant winning aspirations), where the experienced joy increases in the number of outperformed competitors (Boosey et al. 2017), or by spiteful preferences (Morgan et al. 2003), where agents receive utility by harming others, and hence this utility increases in the number of harmed competitors. Empirically, I find an overall positive correlation of spite with sabotage, which suggests that the observed over-sabotage is, at least, partially driven by spiteful preferences. The importance of spiteful preferences adds to other literature which shows that spiteful preferences matter in competitive settings (Mill & Stäbler 2023, Mill & Morgan 2022*a*, Mill 2017). Observing this significant overbidding in sabotage for larger group sizes goes in contrast to Boosey et al. (2017), who do not find any overbidding in effort levels in a contest with group size uncertainty, but in line with the experimental literature on contest with known group sizes, which consistently finds overbidding in effort (Sheremeta 2018, Dechenaux et al. 2015, Sheremeta 2013). Yet, I also do not find any overbidding in effort, nor in the joint effort and sabotage levels.

From a welfare perspective, observing higher than equilibrium sabotage and at the same time, not higher effort levels is bad news, especially for larger groups. The individually exerted oversabotage leads to a drastic increase in the received sabotage when the number of sabotage-exerting contestants increases. Hence, more value is destroyed and individual performances diminished. This illustrates that contrary to theory, sabotage is not necessarily a 'small number phenomena' (Konrad 2000), but sabotage is especially harmful, when the group sizes become larger. As a consequence, increasing the number of contestants to decrease sabotage does not seem to be an apt tool. Instead, if a designer can set and reveal the number of competitors, she should rather determine a smaller number of competitors, as less value is destroyed.

Another additional result is that when contestants do not know the realized number of contestants, I find that an increase in the number of potential contestants decreases effort and sabotage levels, when enter probabilities are high ($q = 0.75$), as predicted. When enter probabilities are low ($q = 0.25$), however, I do not find evidence for the theoretical decrease in effort and sabotage. These results complement Boosey et al. (2017) who do not find a significant difference in effort levels when enter probabilities are low, but a significant increase in effort when enter probabilities are high. Moreover, in line with (Boosey et al. 2017), I find a significant negative association between ambiguity aversion and effort when there is group size uncertainty. Additionally, I find the same negative correlation with sabotage.

The study comes with certain limitations. For instance, I abstract from any spillovers from the exerted sabotage on a baseline productivity of all potential contestants, including non-active players. If the sabotage activities also harm all sabotaged players' baseline productivities, concealment increases this harm, as subjects exert sabotage even when they are alone in the contest. How much harm is done, and which of the counteracting forces between the disclosure policies prevails, depends on the specific parametrization of the baseline productivity and the effectiveness of sabotage on the baseline productivity. For a small enough baseline productivity or small enough effectiveness of sabotage, the results of this paper still hold. Furthermore, I assume exogenous enter probabilities, whereas many times entry into contest may be an endogenous choice. In this paper, exogenous entry probabilities can be thought of as fixing enter beliefs and significantly reducing complexity for subjects. Endogenizing enter probabilities provides an interesting avenue for future research. This is because the possibility of exerting sabotage and getting sabotaged may attract in particular spiteful and tough players, which may potentially lead to additional differences between the disclosure policies and to even more oversabotage for larger group sizes.

Future work should study group sizes larger than five to explore whether the behavioral pattern of oversabotage further increases. Additionally, it would be interesting to expand the disclosure policy to not only disclosing the number of contestants, but also to revealing contestants' identities. If contestants know the identities of their competitors, their sabotage activities can be better targeted. In this way, their sabotage becomes more effective, making it more beneficial to engage in such destructive behavior, leading to more sabotage overall under disclosure compared to concealment. This would further increase the benefits of not disclosing the number of competitors and underlines the welfare enhancing effects of concealing the number of competitors. Finally, as sabotage can destroy value, future work that assesses the welfare consequences of any kind of policies should account for the possibility of such destructive behaviors. Otherwise the welfare assessment might lead to wrong conclusions.

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A Theory Appendix

A.1 First and Second Order Conditions for Maximization Problem

In order to derive the equilibrium effort and sabotage levels, I maximize the individual payoff function with respect to effort and with respect to sabotage for contestant i without loss of generality. Equation 11 is the first order condition with respect to effort and equation 12 the first order conditions with respect to sabotage.

$$\frac{\partial \pi_i}{\partial e_i} = \frac{(\frac{1}{1+\sum_{j\in M_i} s_j})\sum_{l=1}^{m}(\frac{e_l}{1+\sum_{k\in M_l} s_k}) - (\frac{e_i}{1+\sum_{j\in M_i} s_j})(\frac{1}{1+\sum_{j\in M_i} s_j})}{(\sum_{l=1}^{m}\frac{e_l}{1+\sum_{k\in M_l} s_k})^2} W - C'(e_i) = 0 \quad (11)$$

Next, I assume without loss of generality that player i be the m-th player.

$$\frac{\partial \pi_i}{\partial s_i} = \frac{(\frac{e_i}{(1+\sum_{j\in M_i} s_j)})(\frac{e_1}{(1+\sum_{k\in M_1} s_k)^2} + ... + \frac{e_{m-1}}{(1+\sum_{k\in M_{m-1}} s_k)^2})}{(\sum_{l=1}^{m}\frac{e_l}{1+\sum_{k\in M_l} s_k})^2} W - C'(s_i) = 0 \quad (12)$$

The following two second order conditions hold true $\forall e_i > 0, \forall s_i, W \geq 0, \forall i \in M$, where M is the set of all active players. This indicates that the solutions to the first order conditions are maxima:

$$\frac{\partial^2 \pi_i}{\partial e_i^2} = -2\frac{(\frac{1}{(1+\sum_{j\in M_i} s_j)^2})\sum_{j\in M_i}(\frac{e_j}{1+\sum_{k\in M_j} s_k})}{(\sum_{l=1}^{m}\frac{e_l}{1+\sum_{k\in M_l} s_k})^3} W - C''(e_i) < 0 \quad (13)$$

$$\begin{aligned}\frac{\partial^2 \pi_i}{\partial s_i^2} = &-2\frac{(\frac{e_i}{(1+\sum_{j\in M_i} s_j)})(\frac{e_1}{(1+\sum_{k\in M_1} s_k)^3} + ... + \frac{e_{m-1}}{(1+\sum_{k\in M_{m-1}} s_k)^3})}{(\sum_{l=1}^{m}\frac{e_l}{1+\sum_{k\in M_l} s_k})^2} W \\ &+2\frac{(\frac{e_i}{(1+\sum_{j\in M_i} s_j)})(\frac{e_1}{(1+\sum_{k\in M_1} s_k)^2} + ... + \frac{e_{m-1}}{(1+\sum_{k\in M_{m-1}} s_k)^2})^2}{(\sum_{l=1}^{m}\frac{e_l}{1+\sum_{k\in M_l} s_k})^3} W - C''(e_i) < 0\end{aligned} \quad (14)$$

A.2 Proof Proposition 1

Proof. In a symmetric equilibrium, homogeneous contestants choose the same strategies. Hence, the chosen individual effort and sabotage levels are the same for everyone: $e_i = e_{-i} = e$ and $s_i = s_{-i} = s$. As there are m active contestants, everyone receives the sabotage of $m-1$ other contestants. Therefore, the received sabotage is $(m-1)s$. Further, as I assume $C(e_i) = e_i$ and $C(s_i) = s_i$, $C'(e) = C'(s) = 1$. The first order condition with respect to effort (11) becomes:

$$\frac{(\frac{1}{1+(m-1)s})(m\frac{e}{1+(m-1)s}) - (\frac{e}{1+(m-1)s})(\frac{1}{1+(m-1)s})}{m^2(\frac{e}{1+(m-1)s})^2}W = 1$$

$$\iff \frac{(\frac{1}{1+(m-1)s})(m-1)(\frac{e}{1+(m-1)s})}{m^2(\frac{e}{1+(m-1)s})^2}W = 1$$

$$\iff \frac{(m-1)}{m^2}\frac{W}{e} = 1$$

$$\iff e^* = \frac{(m-1)}{m^2}W \tag{15}$$

Likewise, the first order condition with respect to sabotage (12) becomes:

$$\frac{(\frac{e}{1+(m-1)s})(m-1)(\frac{e}{(1+(m-1)s)^2})}{m^2(\frac{e}{1+(m-1)s})^2}W = 1$$

$$\iff \frac{(m-1)}{m^2}\frac{W}{(1+(m-1)s)} = 1$$

$$\iff s^* = \frac{1}{m^2}W - \frac{1}{(m-1)} \tag{16}$$

□

A.3 Proof Proposition 2

Proof. Under group size concealment, the expected profit function is as follows:

$$\mathbb{E}[\pi_i] = \sum_{M_i \in \mathcal{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|} p_i(y_i, y_{-i}, M_i)W - C_i(e_i) - C_i(s_i)$$

First, I take the first order condition of the expected profit function with respect to e_i:

$$\frac{\partial \mathbb{E}[\pi_i]}{\partial e_i} = \sum_{M_i \in \mathbb{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|} \frac{\frac{1}{1+\sum_{j \in M_i} s_j} \sum_{j \in M_i} \frac{e_j}{1+\sum_{k \in M_j} s_k}}{(\frac{e_i}{1+\sum_{j \in M_i} s_j} + \sum_{j \in M_i} \frac{e_j}{1+\sum_{k \in M_j} s_k})^2} W - C_i'(e_i) = 0$$

Next, I employ symmetry and by assumption $C'(e) = 1$. As every contestant is the same, the sum over all possible combinations of other active competitors relaxes to the binomial distribution. It describes the probabilities for each realized number of other contestants $(m-1)$ out of $n-1$ potential contestants. Hence, the equation becomes:

$$\sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-1-(m-1))!} q^{(m-1)}(1-q)^{n-1-(m-1)} \frac{\frac{(m-1)e}{(1+(m-1)s)^2}}{(m-1+1)^2 \frac{e^2}{(1+(m-1)s)^2}} W = 1$$

$$\iff \sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-1-(m-1))!} q^{(m-1)}(1-q)^{n-m} \frac{m-1}{m^2} \frac{W}{e} = 1$$

$$\iff e^* = \sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-m)!} q^{(m-1)}(1-q)^{n-m} \frac{m-1}{m^2} W \tag{17}$$

Subsequently, I take the first order condition with respect to s_i:

$$\frac{\partial \mathbb{E}[\pi_i]}{\partial s_i} = \sum_{M_i \in \mathbb{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|} \frac{\frac{e_i}{1+\sum_{j\in M_i} s_j} \sum_{j\in M_i} \frac{e_j}{(1+\sum_{k\in M_j} s_k)^2}}{\left(\frac{e_i}{1+\sum_{j\in M_i} s_j} + \sum_{j\in M_i} \frac{e_j}{1+\sum_{k\in M_j} s_k}\right)^2} W - C_i'(s_i) = 0$$

After employing symmetry, $C'(s) = 1$, and the binomial coefficient, the equation becomes the following:

$$\sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-1-(m-1))!} q^{(m-1)}(1-q)^{n-1-(m-1)} \frac{\frac{(m-1)e^2}{(1+(m-1)s)^2}}{(m-1+1)^2 \frac{e^2}{(1+(m-1)s)^2}} W = 1$$

$$\iff \sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-m)!} q^{(m-1)}(1-q)^{n-m} \frac{m-1}{m^2} \frac{1}{1+(m-1)s} W = 1$$

Which does not yield a closed form solution and hence I solve it numerically. Further, the second order conditions follow immediately from equation (13) and (14) and hold such that the FOC describe the maxima. □

A.4 Expected Effort, Sabotage, and Payoffs

In this section, I compare the expected effort and sabotage levels between disclosure and concealment. When the group size realization is zero, i.e., when there is no contestants at all, there is no effort under both disclosure policies. Therefore, it suffices to show that the implemented effort is the same conditional on at least one player participating. Hence, conditional on at least one player participating, the expected efforts are as follows:

$$Concealment: \mathbb{E}[e] = \sum_{(m-1)=0}^{n-1} \underbrace{\frac{(n-1)!}{(m-1)!(n-m)!} q^{m-1}(1-q)^{n-m}}_{\text{Probability of group size } m} \underbrace{e^*}_{\text{Effort concealment}} = \underbrace{e^*}_{\text{Effort concealment}}$$

$$Disclosure: \mathbb{E}[e] = \sum_{(m-1)=0}^{n-1} \underbrace{\frac{(n-1)!}{(m-1)!(n-m)!} q^{m-1}(1-q)^{n-m}}_{\text{Probability of group size } m} \underbrace{\frac{(m-1)}{m^2} W}_{\text{Effort disclosure}} = \underbrace{e^*}_{\text{Effort concealment}}$$

Under concealment, conditional on one player being active, the expected effort is simply the equilibrium effort under concealment, because contestants exert the same effort for each realized group size. Under concealment, the weighted sum over the equilibrium choice for the specific realized group size is taken. This is exactly, how the equilibrium effort decision under concealment is computed (see equation 17). Hence, the two expected efforts are equivalent.

As the equilibrium sabotage under concealment cannot be solved analytically, I compare the numerical solutions under both policies. Figure 15 depicts the expected sabotage, conditional on at least one player being active, under both policies and shows that there are only very small and negligible differences, if any. Therefore, I show that there are no substantial differences between average sabotage levels under concealment and under disclosure.

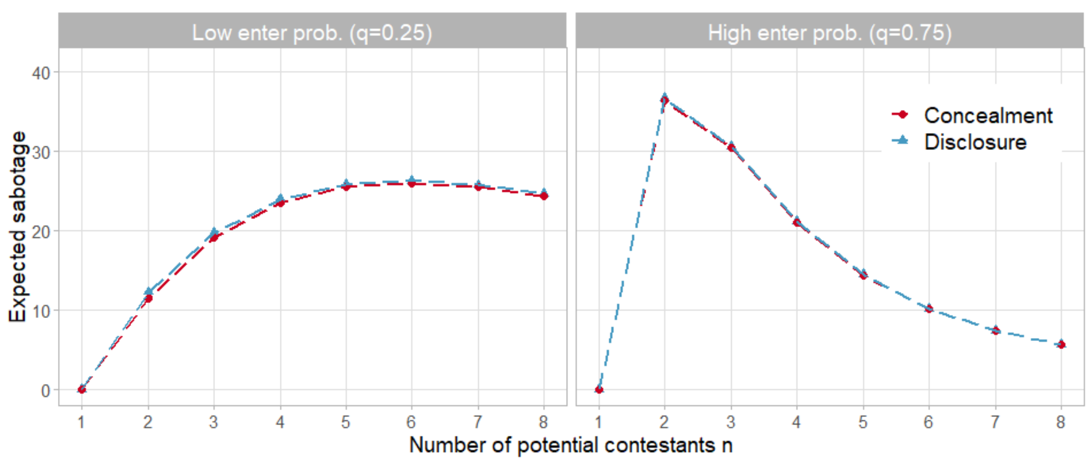

Figure 15: Expected sabotage under concealment compared to disclosure for low and high enter probabilities. The x-axes show the group size of all potential contestants (active and non-active). The y-axes show the average sabotage levels. Red lines indicate concealment and blue lines disclosure.

A.5 Expected Individual Payoff Simulation

In this section, I show that the individual expected payoff is not substantially different between disclosure policies. For this, I calculate the expected payoff conditional on participation. Because of symmetry, all players employ the same effort and sabotage. Therefore, performances are identical and all active players' winning probabilities reduce to: $p_{win} = \frac{1}{m}$, with m being the realized number of active players. Under disclosure, conditional on participating, the expected payoff for player i is as follows:

$$E[\pi_i]_{Disclosure} = \sum_{(m-1)=0}^{n-1} \Bigg(\underbrace{\frac{(n-1)!}{(m-1)!(n-m)!} q^{m-1}(1-q)^{n-m}}_{\text{probability for } m-1 \text{ other active players}} \times \underbrace{\frac{1}{m}}_{\text{probability to win}} \times W - \underbrace{e^*(m) - s^*(m)}_{\text{costs}} \Bigg) \quad (18)$$

Conditional on concealment, the expected payoff for a participant, conditional on participating is as follows:

$$E[\pi_i]_{Concealment} = \sum_{(m-1)=0}^{n-1} \Bigg(\underbrace{\frac{(n-1)!}{(m-1)!(n-m)!} q^{m-1}(1-q)^{n-m}}_{\text{probability for } m-1 \text{ other active players}} \times \underbrace{\frac{1}{m}}_{\text{probability to win}} \times W \Bigg) - \underbrace{e^*(q,n) - s^*(q,n)}_{\text{costs}} \quad (19)$$

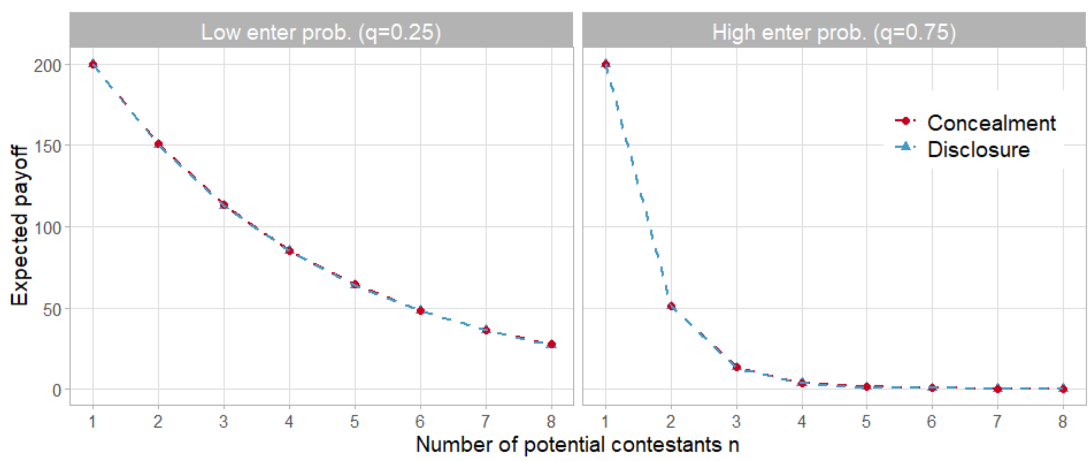

Figure 16: Expected individual utility conditional on low enter probability $q = 0.25$ (left graph) or high enter probability $q = 0.75$ (right graph). The x-axes show the group size of all potential contestants (active and non-active). The y-axes show the expected individual utility. Red lines indicate concealment and yellow lines disclosure of the number of active contestants.

Figure 16 shows the numerical solution and indicates that there is no substantial difference between the individual ex-ante expected payoffs between disclosing and concealing the number of participants. It further shows that expected payoffs decrease both in the number of potential contestants and in their enter probabilities. This is because the player win with certainty, if they are the only contestants, and the probability of being alone in the contest decreases with an increasing number of potential contestants and enter probabilities.

A.6 Robustness Effectiveness of Sabotage

This section provides a robustness check for the theoretical results, with a slightly different performance function that allows for a different effectiveness in the received sabotage. Specifically, I use the following performance function:

$$y_i = \frac{e_i}{(1+(m-1)s)^t}$$

I show that the difference in the expected group performance still holds for different parameters of t. As $\lim_{t\to 0}$, however, the difference disappears. Yet, this is not surprising, because $\lim_{t\to 0}$ means that sabotage has no influence on the performance overall and thus cannot induce differences between the disclosure policies. When contestants know the number of active contestants m, The effort and sabotage levels in the symmetric equilibrium look as follows:

$$e^* = \frac{(m-1)}{m^2}W$$

$$s^* = \begin{cases} t\frac{1}{m^2}W - \frac{1}{m-1} & \text{if } W \geq \frac{m^2}{t(m-1)} \text{ and } m \geq 2 \\ 0 & \text{else} \end{cases}$$

Note that only the equilibrium sabotage levels are effected by the effectiveness of sabotage parameter t. Specifically, the less effective (higher t) sabotage, the lower are equilibrium sabotage levels. As sabotage levels are (almost) the weighted sum of the group size disclosure levels, a lower t also leads to lower sabotage levels under concealment. Figure 17 shows the numerical solutions of the expected group performances for different levels of t, i.e., $t \in \{0.25, 0.5, 1, 2\}$. It shows that even for a small effectiveness of sabotage, which also induces lower sabotage levels overall, the difference between concealment and disclosure is still pronounced. However, this difference becomes smaller, the smaller t, with no differences as $\lim_{t\to 0}$. Nonetheless, for not too low values of t, the differences are pronounced between the disclosure policies. Therefore, this analysis shows that the differences in the group performance between the disclosure policies remains robust, even if the performance function does not carry as pronounced decreasing marginal return in the received sabotage.

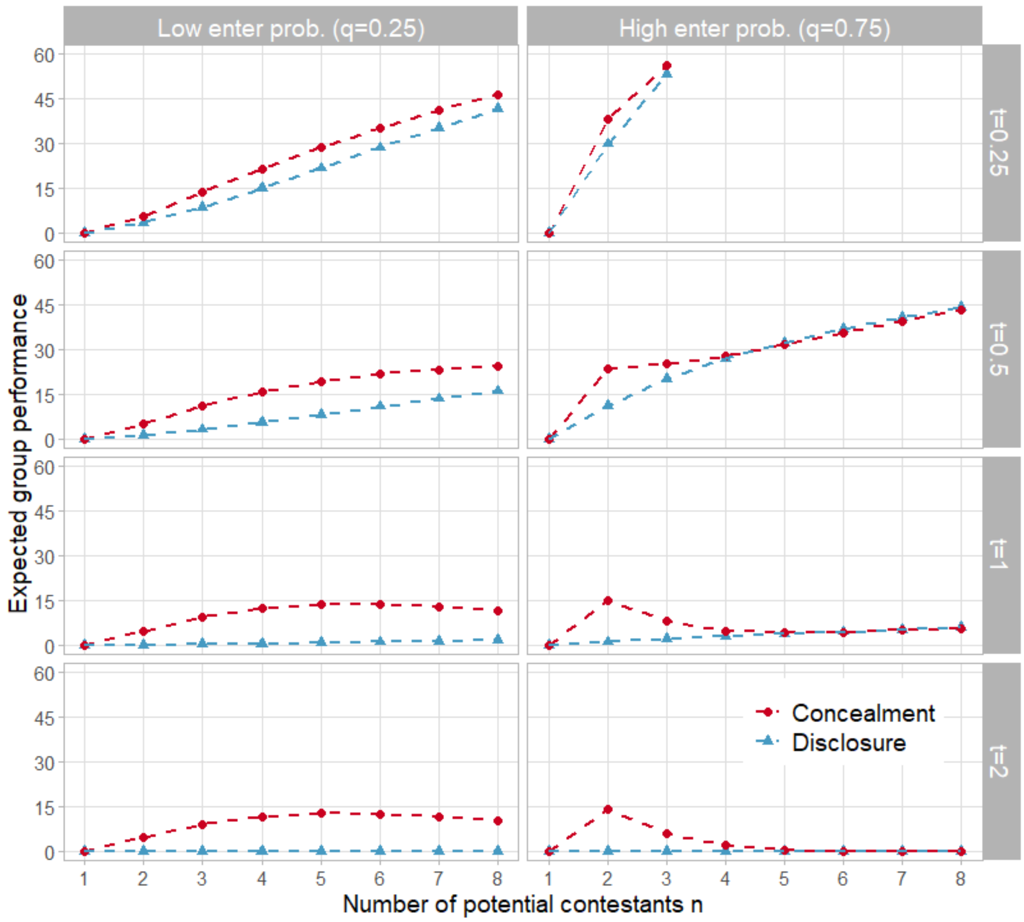

Figure 17: Expected group performance (sum of individual performances) conditional on the disclosure policy for low (left panel) and high (right panel) enter probabilities. The four rows vary the effectiveness of sabotage parameter $t \in \{0.25, 0.5, 1, 2\}$.

A.7 Preference for Donations

Suppose that agents have a preference for donations D and/ or efficiency. Specifically, suppose that agents' utility from donations are described by $U_{donations} = \alpha D$ and for simplicity that the utility gains from own payoff and the donations is additive, such that $U_i = \pi_i + \alpha D$ with $\alpha \in [0, 1)$. The equilibrium levels under group size disclosure and group size uncertainty are only marginally influenced by the preference for donations parameter α. As a consequence, the comparative statics remain the same. Furthermore, the expected group performances and thus the difference between the expected performances between the disclosure policies are also only marginally affected by this preference for donations parameter. As a conclusion, the main theoretical comparative statics are robust to the inclusion of preferences for donation.

A.7.1 Group Size Disclosure

Conditional on the realized group size m with the set of active player M, the overall expected utility under group size disclosure is then described by:

$$\mathbb{E}[U_i] = \frac{y_i}{\sum_{j \in M} y_j} W + \alpha(\sum_{j \in M} y_j + 10) - e_i - s_i \tag{20}$$

with $y_i = \frac{e_i}{1+\sum_{j \neq i} s_j}$ and $\frac{y_i}{\sum_{j \in M} y_j} = \frac{1}{n}$, if $y_i = 0 \ \forall i \in M$. Suppose, agents simultaneously maximize their expected utility by choosing e_i and s_i. Then the equilibrium effort and sabotage levels can be described by the following two equation:

$$e^* = \frac{-\sqrt{(m-1)^2 W^2 - 4(m-1)\alpha m^2 \left(m - \frac{1}{2}\right) W + \alpha^2 m^4} + (2W - \alpha) m^2 - 3Wm + W}{2m^2(m-1)} \tag{21}$$

$$s^* = \frac{Wm - 2m^2 + \sqrt{2\sqrt{(m-1)^2 W^2 - 4a(m-1)\left(m - \frac{1}{2}\right) m^2 W + a^2 m^4}\, a\, m^2 + (m-1)^2 W^2 - 4a(m-1)\left(m - \frac{1}{2}\right) m^2 W + 2a^2 m^4} - W}{2m^2(m-1)} \tag{22}$$

Proof. Suppose that agents simultaneously maximize their expected payoff:

$$\mathbb{E}[\pi_i] = \frac{y_i}{\sum_{j \in M} y_j} W + \alpha(\sum_{j \in M} y_j + 10) - e_i - s_i$$

with $y_i = \frac{e_i}{1+\sum_{j \neq i} s_j}$ and $\frac{y_i}{\sum_{j \in M} y_j} = \frac{1}{m}$, if $y_i = 0 \ \forall i \in M$. First, I take the first order condition of the expected profit function with respect to e_i:

$$\frac{\partial \pi_i}{\partial e_i} = \frac{(\frac{1}{1+\sum_{j \neq i} s_j)}) \sum_{j=1}^{m} (\frac{e_j}{1+\sum_{l \neq j} s_l)}) - (\frac{e_i}{1+\sum_{j \neq i} s_j})(\frac{1}{1+\sum_{j \neq i} s_j})}{(\sum_{j=1}^{m} \frac{e_j}{1+\sum_{l \neq j} s_l})^2} W + \alpha \frac{1}{1+\sum_{j \neq i} s_j} - 1 = 0$$

Applying symmetry yields:

$$\frac{(m-1)}{m^2} \frac{W}{e} + \alpha \frac{1}{1+(m-1)s} = 1 \tag{23}$$

Next, suppose without loss of generality that player i is the m-th player. I then take the first order condition with respect to s_i:

$$
\begin{aligned}
\frac{\partial \pi_i}{\partial s_i} = & \frac{\left(\frac{e_i}{(1+\sum_{j\neq i} s_j)}\right)\left(\frac{e_1}{(1+\sum_{l\neq 1} s_l)^2} + ... + \frac{e_{m-1}}{(1+\sum_{l\neq m-1} s_l)^2}\right)}{\left(\sum_{j=1}^{m} \frac{e_j}{1+\sum_{l\neq j} s_l}\right)^2} W \\
& + \alpha\left(-\frac{e_1}{(1+\sum_{l\neq 1} s_l)^2} - ... - \frac{e_{m-1}}{(1+\sum_{l\neq m-1} s_l)^2}\right) - 1 = 0
\end{aligned}
$$

Symmetry yields:

$$
\begin{aligned}
& \frac{(m-1)}{m^2} \frac{W}{(1+(m-1)s)} - \alpha(m-1)\frac{e}{(1+(m-1)s)^2} = 1 \\
\implies s_{1,2} = & \frac{(m-1)W - 2m^2 \pm \sqrt{(m-1)^2W^2 - 4\alpha m^4(m-1)e}}{2m^2(m-1)}
\end{aligned}
$$

As this yields two solutions, I check which of the two is admissible. For this I plug in $\alpha = 0$ to see whether the expression collapses to the solution without preferences for donations. This is only true for $s_1 = \frac{(m-1)W-2m^2+\sqrt{(m-1)^2W^2-4\alpha m^4(m-1)e}}{2m^2(m-1)}$. I now take s_1 and plug it into equation 23:

$$
\begin{aligned}
& \frac{(m-1)}{m^2} \frac{W}{e} + \alpha \frac{1}{1+(m-1)\frac{(m-1)W-2m^2+\sqrt{(m-1)^2W^2-4\alpha m^4(m-1)e}}{2m^2(m-1)}} = 1 \\
\implies e_{1,2} = & \frac{\pm\sqrt{(m-1)^2 W^2 - 4(m-1)\alpha m^2 \left(m-\frac{1}{2}\right) W + \alpha^2 m^4} + (2W-\alpha)m^2 - 3Wm + W}{2m^2(m-1)}
\end{aligned}
$$

Similarly, to determine, which of the two solutions for e is admissible, I plug in $\alpha = 0$ and see, if the solution relaxes to $e = \frac{(m-1)}{m^2}W$, which is the case without any preferences for donations. This is only the case for:

$$
e^* = \frac{-\sqrt{(m-1)^2 W^2 - 4(m-1)\alpha m^2 \left(m-\frac{1}{2}\right) W + \alpha^2 m^4} + (2W-\alpha)m^2 - 3Wm + W}{2m^2(m-1)} \tag{24}
$$

Plugging this into s_1 yields:

$$
s^* = \frac{Wm - 2m^2 + \sqrt{2\sqrt{(m-1)^2 W^2 - 4a(m-1)\left(m-\frac{1}{2}\right)m^2W + a^2m^4}\, a\, m^2 + (m-1)^2 W^2 - 4a(m-1)\left(m-\frac{1}{2}\right)m^2W + 2a^2m^4} - W}{2m^2(m-1)} \tag{25}
$$

which relaxes to $s = \frac{1}{m^2}W - \frac{1}{m-1}$ for $\alpha = 0$ and hence is admissible. $\square$

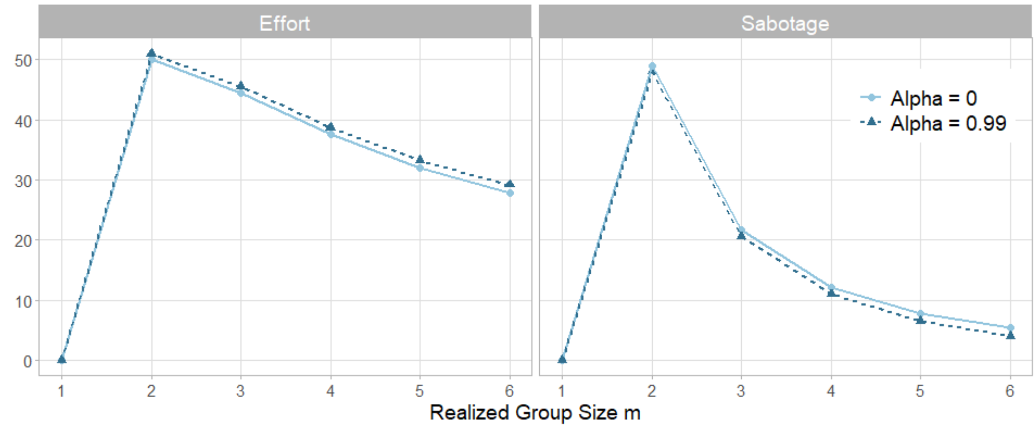

Figure 18: Equilibrium effort and sabotage levels conditional on the known realized group size m and the preference for donation parameter α. Dashed dark blue lines indicate a high preference for donations and light blue lines no preference for donations.

Figure 18 illustrates the equilibrium effort and sabotage levels for a preference for donations parameter of $\alpha = 0$ and $\alpha = 0.99$. It shows that a preference for donations only marginally changes the equilibrium choices. Specifically, effort levels are slightly higher and sabotage levels slightly lower. More importantly, a preference for donations does not change the comparative statics of the realized group size. This is because the marginal benefit of increasing the winning probability of the prize W through higher effort is much greater than the marginal benefit of more donations through lower sabotage.

A.7.2 Group Size Concealment

The expected utility with a preference for donations under group size concealment is as follows:

$$\mathbb{E}[\pi_i] = \sum_{M_i \in \mathcal{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|}\left[\frac{y_i}{\sum_{j\in M} y_j}W + \alpha(\sum_{j\in M} y_j + 10)\right] - e_i - s_i$$

with $y_i = \frac{e_i}{1+\sum_{j\neq i} s_j}$ and $\frac{y_i}{\sum_{j\in M} y_j} = \frac{1}{m}$, if $y_i = 0\ \forall i \in M$. The first order condition of the expected profit function with respect to e_i is:

$$\frac{\partial \pi_i}{\partial e_i} = \sum_{M_i \in \mathcal{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|}[\frac{(\frac{1}{1+\sum_{j\neq i} s_j})\sum_{j=1}^{m}(\frac{e_j}{1+\sum_{l\neq j} s_l}) - (\frac{e_i}{1+\sum_{j\neq i} s_j})(\frac{1}{1+\sum_{j\neq i} s_j})}{(\sum_{j=1}^{m}\frac{e_j}{1+\sum_{l\neq j} s_l})^2}W$$
$$+\alpha\frac{1}{1+\sum_{j\neq i} s_j}] - 1 = 0$$

I now apply symmetry. With homogenous contestants, the sum over all possible sets of all other active contestants. relaxes to all possible number of others. For readability, I define $B_{m-1}^{n-1} = \sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-1-(m-1))!} q^{(m-1)}(1-q)^{n-1-(m-1)}$:

$$B_{m-1}^{n-1}\left[\frac{(m-1)}{m^2}\frac{W}{e} + \alpha\frac{1}{1+(m-1)s}\right] = 1$$

$$\iff e = \frac{B_{m-1}^{n-1}\frac{m-1}{m^2}W}{1 - B_{m-1}^{n-1}\alpha\frac{1}{1+(m-1)s}} \tag{26}$$

Next, suppose without loss of generality that player i is the m-th player. The first order condition with respect to s_i is:

$$\frac{\partial \pi_i}{\partial s_i} = \sum_{M_i \in \mathcal{P}^{N_i}} q^{|M_i|}(1-q)^{|N_i/M_i|}\left[\frac{\left(\frac{e_i}{(1+\sum_{j\neq i} s_j)}\right)\left(\frac{e_1}{(1+\sum_{l\neq 1} s_l)^2} + ... + \frac{e_{m-1}}{(1+\sum_{l\neq m-1} s_l)^2}\right)}{\left(\sum_{j=1}^{m}\frac{e_j}{1+\sum_{l\neq j} s_l}\right)^2}W\right.$$
$$\left. +\alpha\left(-\frac{e_1}{(1+\sum_{l\neq 1} s_l)^2} - ... - \frac{e_{m-1}}{(1+\sum_{l\neq m-1} s_l)^2}\right)\right] - 1 = 0$$

Applying symmetry, and again with $B_{m-1}^{n-1} = \sum_{(m-1)=0}^{n-1} \frac{(n-1)!}{(m-1)!(n-1-(m-1))!} q^{(m-1)}(1-q)^{n-1-(m-1)}$, it becomes:

$$B_{m-1}^{n-1}\left[\frac{(m-1)}{m^2}\frac{W}{(1+(m-1)s)} - \alpha(m-1)\frac{e}{(1+(m-1)s)^2}\right] = 1 \tag{27}$$

Which does not yield a closed-form solution for s. Hence, I solve equations 26 and 27 numerically. Figure 19 shows the numerical solution for the parameters of interest. It shows the equilibrium effort and sabotage levels for a preference for donations parameter of $\alpha = 0$ and $\alpha = 0.99$. It reveals only marginal differences in the effort and sabotage levels between these parameters.

A.7.3 Comparison Disclosure Policies

Figure 20 depicts the difference in expected group performances between concealment and disclosure for a preference for donation parameter of $\alpha = 0$ (upper row) and $\alpha = 0.99$. The difference between the disclosure policies is almost the same between the two parameters. Consequently, a preference for donation parameter does also not change this comparative static.

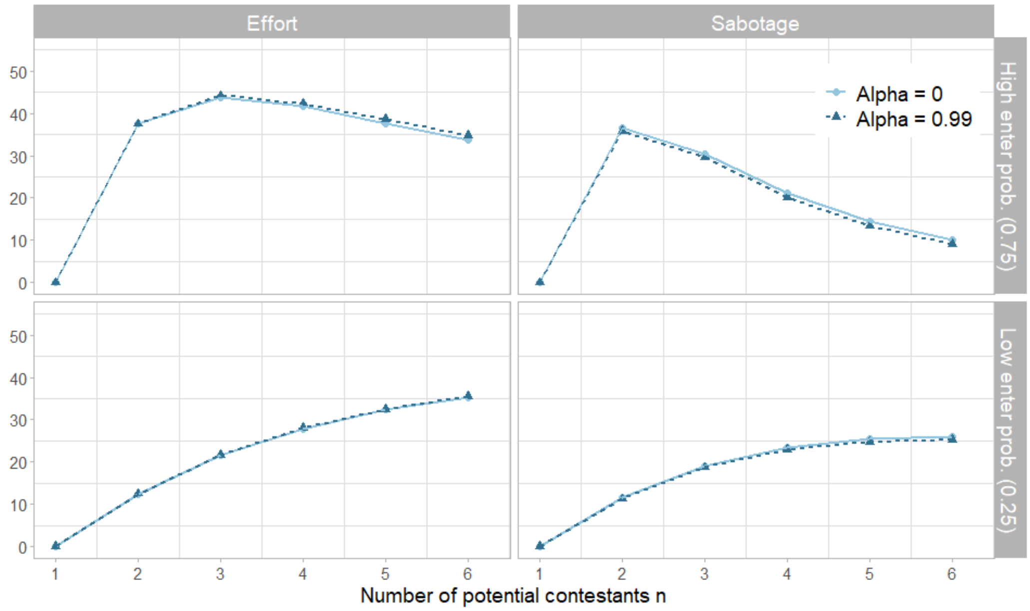

Figure 19: Equilibrium effort and sabotage levels under group size uncertainty conditional on the preference for donation parameter α. Dashed dark blue lines indicate a high preference for donations and light blue lines no preference for donations.

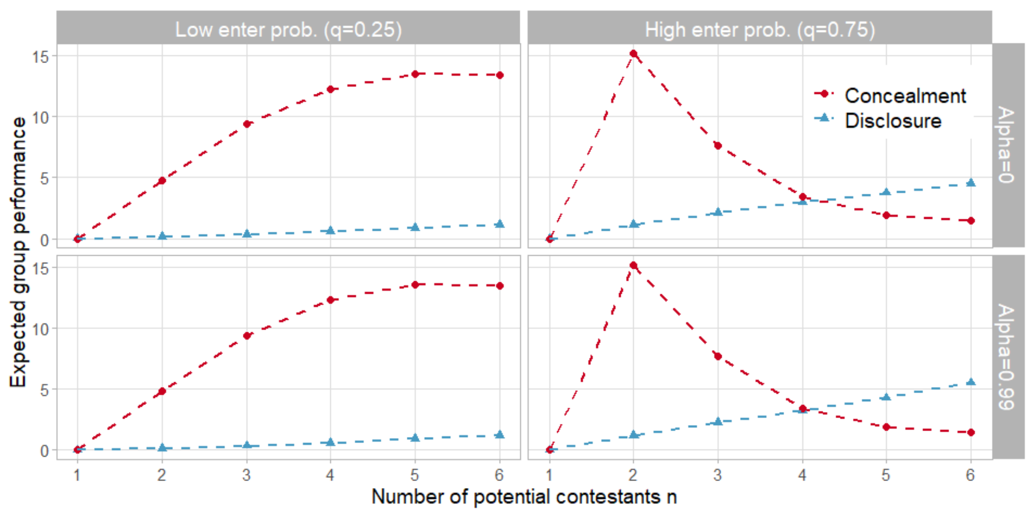

Figure 20: Expected group performance under concealment (red) and disclosure (blue) for low enter probabilities (left) and high enter probabilities (right) for either $\alpha = 0$ (upper row) or $\alpha = 0.99$ (lower row).

B Experimental Design Appendix

Figure 21 shows the communicated group size probabilities in part B of the experiment for the treatment *5H*. For all other treatments, this looked the same but only with the respective probabilities and possible number of active group members (only 0, 1, 2 for the treatments *3L* and *3H*).

Probabilities for the number of other active group members, if you are active

Number of other active group members	Probabilities
0	0.4%
1	4.7%
2	21.1%
3	42.2%
4	31.6%

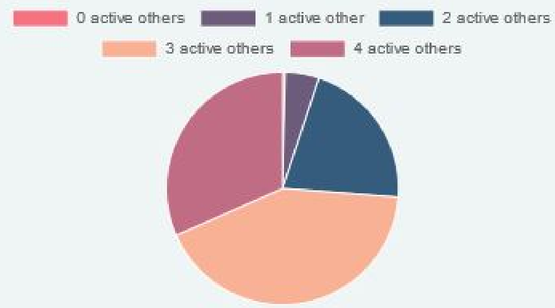

Figure 21: Communicated group size probabilities in part B (for treatment *5H*)

Figure 22 shows the probability calculator that subjects had access to at any time. By clicking on advanced calculator, they could enter Option-A and Option-B choices for each of their potential competitors individually.

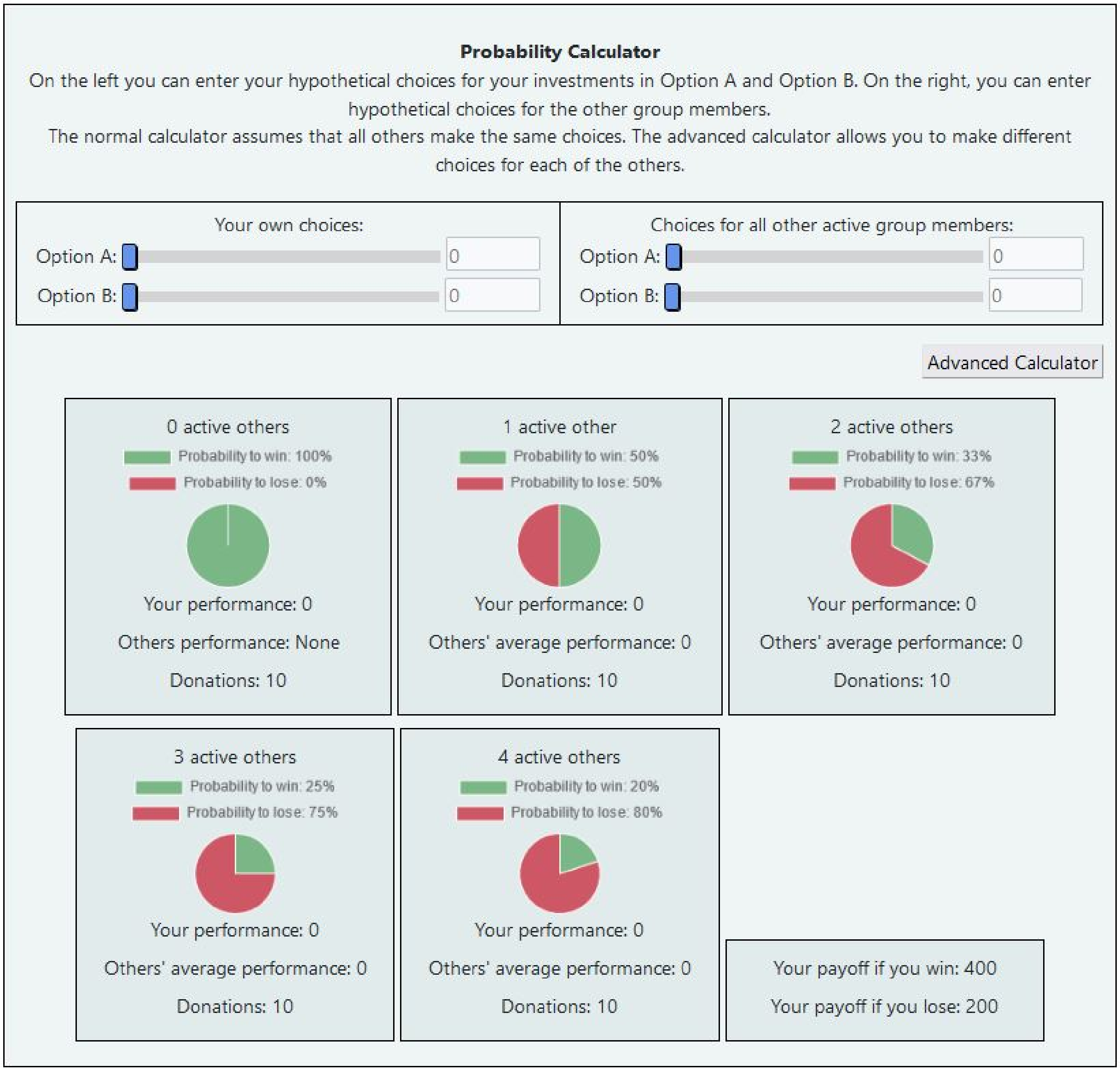

Figure 22: Probability calculator

C Results Appendix

C.1 Disclosure Policy

C.1.1 Effort, Sabotage, and Expected Payoff per Treatment

Figure 23 shows effort and sabotage differences across the policies conditional on the treatments. It shows that there are are no significant differences in effort and sabotage levels between the disclosure policies for any of the treatments, with the exception of treatment *3L*, where concealment increases sabotage levels ($p < 0.1$). The robustness checks confirm these results (see appendix C.1.3), and find a significant

($p < 0.05$) increase in sabotage under concealment for treatment *3L* treatment.[51]

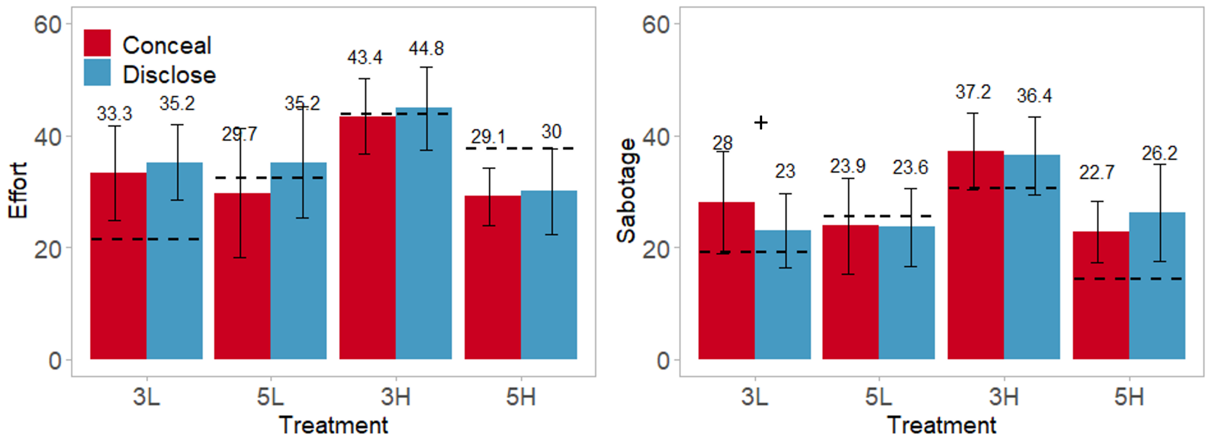

Figure 23: The bar charts show the average effort (left panel) and sabotage (right panel) conditional on the disclosure policy and on the treatments. Black dashed lines show the Nash equilibrium predictions. The error bars show 95% confidence intervals. Significance levels: + $p < 0.10$

Figure 24 compares the expected payoff between the disclosure policies for each treatment (left panel) and pooled over all treatments (right panel). It shows that there are no significant differences between the disclosure policies for all treatments. The robustness checks also do not find any significant differences (see appendix C.1.3)

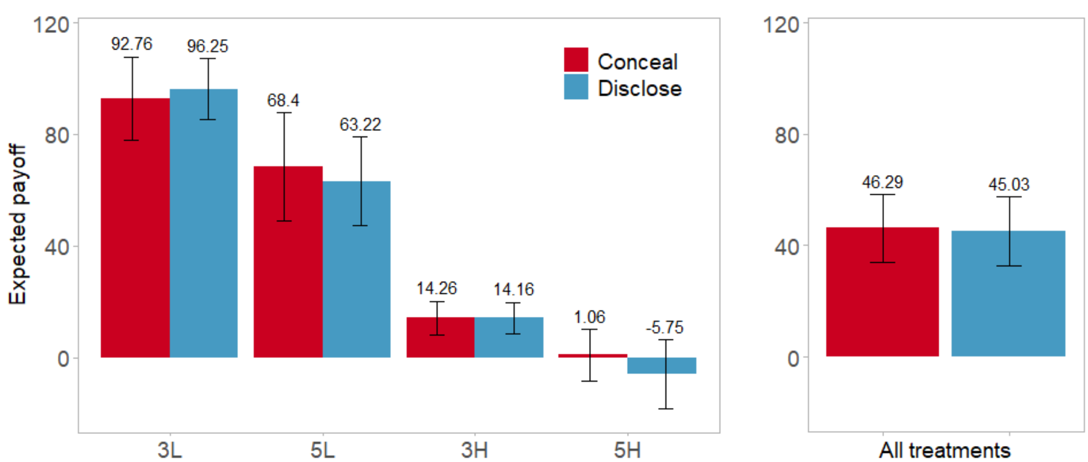

Figure 24: The figure depicts the individual expected payoffs based on the subjects' choices conditional on the treatments (left panel) or pooled over all treatments (right panel). Error bars show 95% confidence intervals.

[51]Specifically, I find a significant ($p < 0.05$) increase under concealment for treatment *3L*, when studying only the rounds around the policy changes and in the regression analysis. Apart from that, there is no significant difference in effort and sabotage levels between the disclosure policies in the robustness checks.

C.1.2 Time Trends

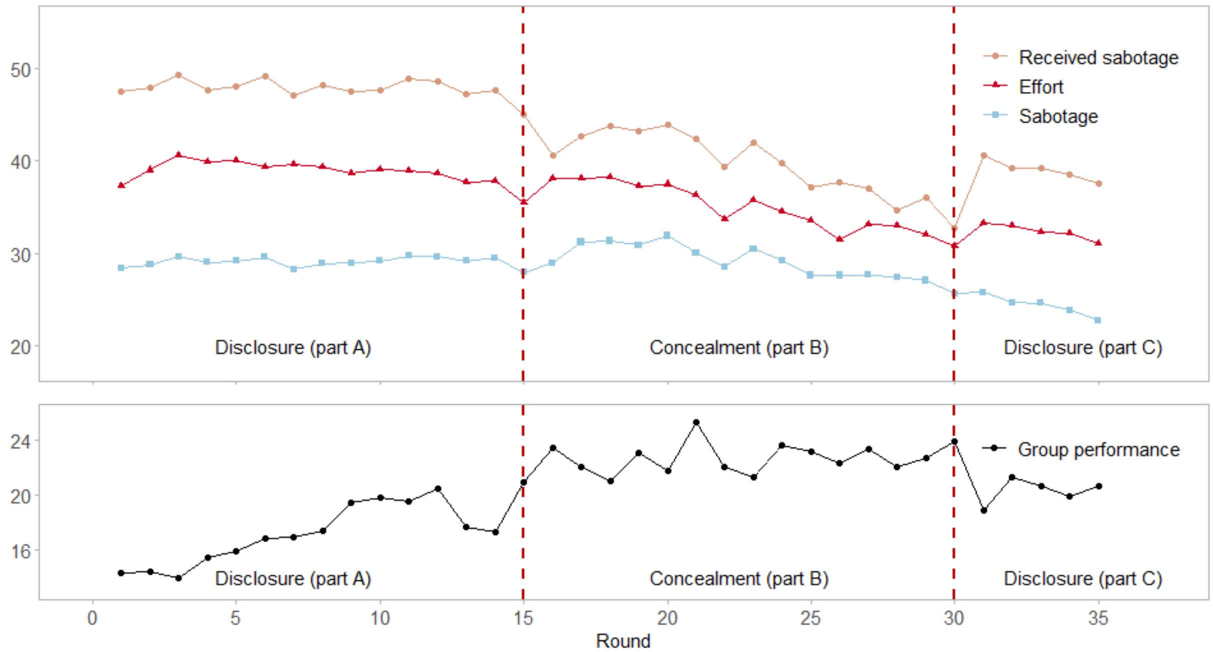

Figure 25: The two panels show the average expected received sabotage, the average expected effort and sabotage levels, and the average expected group performance, based on the subjects' choices over all rounds.

Figure 25 depicts the time trends of the expected received sabotage, the expected effort and sabotage levels, as well as the expected group performance over all rounds and pooled over all treatments. The upper panel shows that there is a slight decrease in the expected choices over time, whereas the lower panel shows that there is a slight increase in the expected group performance over time. Therefore, I conduct the two robustness checks, where I first focus only on the rounds around the disclosure policy changes and on regression analyses that control for the time trend. The robustness checks mostly support the results of the main section.

C.1.3 Robustness Check Effort, Sabotage and Expected Payoff

Subset of Rounds around Policy Change

Because of the time trend, I focus on the rounds that are in the neighborhood of the disclosure policies, i.e. rounds 11-20 and 21-30. The following figure show the pooled averages only for those rounds. Figure 26 shows the pooled averages over all treatments. It shows no significant differences in average expected effort, expected sabotage levels, and expected payoffs between the disclosure policies. Figure 27 shows average expected effort and sabotage conditional on the disclosure policy and on each treatment. It shows no significant differences in levels between the policies, but for treatment *3L*, where concealment leads to significantly ($p < 0.05$) higher sabotage levels. Similarly, figure 28 shows the expected payoff conditional on the disclosure policy for each treatment individually. It, too, shows no significant difference between the disclosure policies.

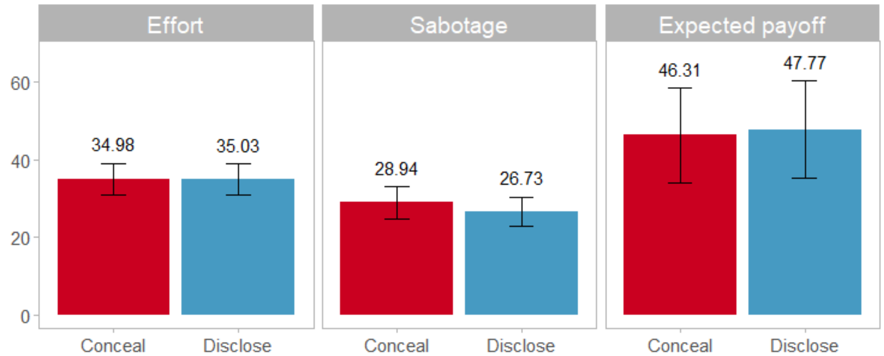

Figure 26: The figure shows average effort, sabotage, and expected payoffs conditional on the disclosure policy, pooled over all treatments. The figure is based solely on rounds 11-20 and 21-30 (around policy changes). Error bars show 95% confidence intervals. Significance levels: + $p < 0.10$

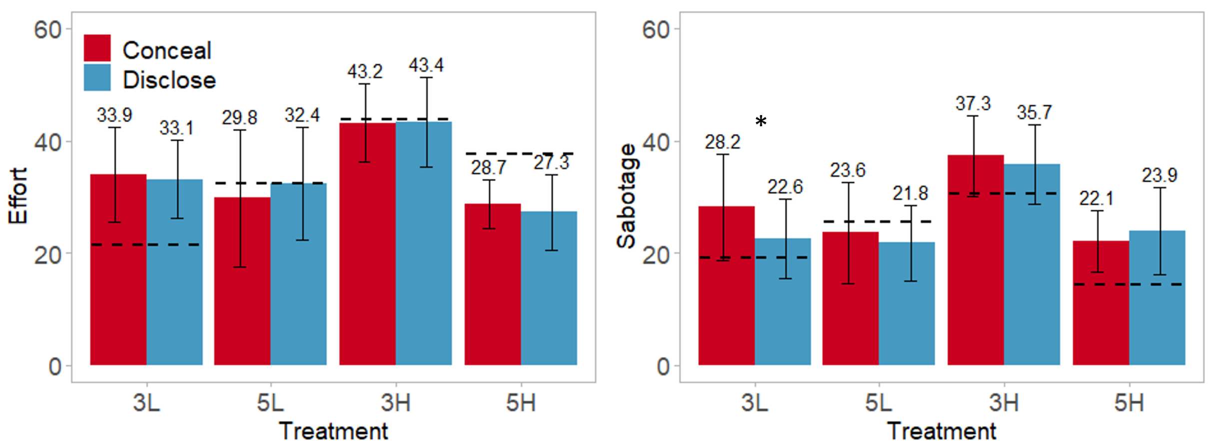

Figure 27: The bar charts show the average effort (left panel) and sabotage (right panel) conditional on the disclosure policy and on the treatments for the rounds 11-20 and 21-30 (around policy changes). The error bars show 95% confidence intervals. Significance levels: * $p < 0.05$

Regression Analyses

As an additional robustness check, I run linear regression models, which control for the time trend. I cluster standard errors at the group level. In accordance with the preregistration, I include models that control for being active in the round before, having won in the round before, average sabotage and effort levels of other participants in the rounds before, round, determined group size in the round before, how often won in the rounds before, SVO, spite, risk, loss and ambiguity aversion, age, gender, highest degree, the field of study, the degree of concentration and understanding. I additionally include the treatments as controls. Table 1 shows no significant difference in effort levels and expected payoffs between the

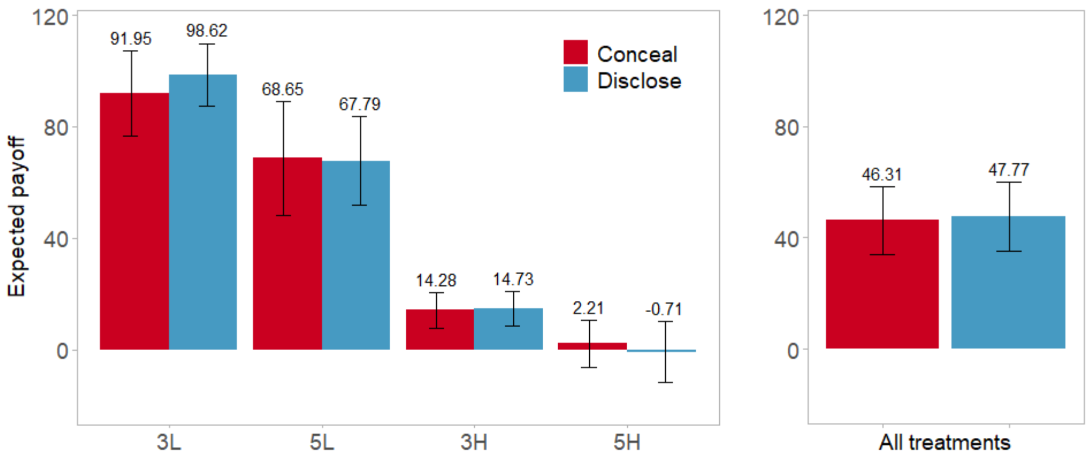

Figure 28: The figure depicts the average expected individual payoffs based on the subjects' choices conditional on the treatments (left panel) or pooled over all treatments (right panel) for the rounds 11-20 and 26-30. Error bars show 95% confidence intervals.

disclosure policies. It further shows that concealment significantly ($p < 0.05$) increases sabotage levels.

Next, I run the same regression, but conditional on the specific treatments. Table 2 shows linear regressions of the expected average effort and sabotage levels on concealment but for each treatment seperately.It confirms the significant ($p < 0.05$) increase in sabotage levels under concealment for the treatment $3L$ and additionally shows a significant ($p < 0.05$) increase in effort under concealment under 5H. Finally, I run the same regressions but for expected payoffs. Again, it does not show any significant differences between the disclosure policies for any of the treatments (table 3).

Table 1: Linear regression expected effort, sabotage, and payoff on concealment and controls

	Dependent variable:		
	effort	sabotage	expected payoff
	(1)	(2)	(3)
Concealment	0.43	2.20^{*}	−0.18
	(1.09)	(1.11)	(1.50)
Round	-0.59^{***}	-0.40^{***}	0.65^{***}
	(0.10)	(0.08)	(0.11)
Risk Aversion	−1.72	−1.64	1.18
	(1.51)	(1.34)	(1.82)
Loss Aversion	−0.59	−1.03	−1.54
	(0.86)	(0.88)	(1.02)
Ambiguity Aversion	-3.09^{*}	-2.04^{+}	3.34^{**}
	(1.35)	(1.08)	(1.26)
SVO	0.19	0.11	−0.19
	(0.18)	(0.17)	(0.17)
Spite	10.43	18.35^{*}	0.63
	(8.75)	(8.89)	(9.63)
Female	6.99^{+}	5.87^{+}	-6.03^{+}
	(3.94)	(3.39)	(3.53)
Age	0.18	−0.58	−0.42
	(0.63)	(0.48)	(0.63)
Constant	46.39^{*}	64.84^{***}	39.78^{*}
	(20.75)	(18.75)	(20.10)
Treatment Dummies	✓	✓	✓
Other Controls	✓	✓	✓
Observations	6,630	6,630	6,630
# Clusters	52	52	52
R^2	0.16	0.15	0.69

Note: SE clustered at group level + $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 2: Linear regression expected effort and sabotage on disclosure and controls for different treatments

	Dependent variable:							
	effort	sabotage	effort	sabotage	effort	sabotage	effort	sabotage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Concealment	0.58	4.98^{*}	−0.89	3.18	0.62	1.91	3.99^{*}	1.03
	(2.61)	(2.08)	(2.82)	(3.34)	(1.76)	(1.44)	(1.84)	(2.10)
Round	−0.28	−0.01	-0.82^{**}	-0.64^{*}	-0.34^{*}	-0.34^{**}	-1.01^{***}	-0.76^{***}
	(0.19)	(0.09)	(0.28)	(0.28)	(0.16)	(0.12)	(0.22)	(0.18)
Risk Aversion	-8.53^{**}	-8.90^{***}	-2.71^{*}	−1.78	-5.58^{*}	-6.75^{***}	0.93	1.52
	(2.85)	(1.85)	(1.16)	(1.29)	(2.52)	(1.94)	(3.31)	(2.57)
Loss Aversion	2.83	2.47	−0.12	0.09	-4.30^{**}	-3.11^{*}	−2.06	-3.51^{**}
	(2.31)	(2.02)	(1.47)	(1.49)	(1.58)	(1.56)	(1.41)	(1.27)
Ambiguity Aversion	−2.90	-2.99^{**}	−2.68	−2.33	−3.00	−1.02	−0.24	0.50
	(1.89)	(0.99)	(2.19)	(2.01)	(3.16)	(3.35)	(1.57)	(1.13)
SVO	−0.05	0.09	−0.30	-0.52^{+}	0.50	−0.04	−0.14	0.11
	(0.38)	(0.20)	(0.35)	(0.30)	(0.33)	(0.29)	(0.45)	(0.44)
Spite	11.10	9.64	47.84^{+}	23.49	35.91^{+}	35.65^{**}	−3.31	31.31
	(12.18)	(10.22)	(25.69)	(25.58)	(18.58)	(12.65)	(43.03)	(34.87)
Female	−9.91	−0.79	−5.10	0.80	4.25	−1.24	17.83^{***}	17.81^{***}
	(6.64)	(2.99)	(11.66)	(11.13)	(7.13)	(6.60)	(3.96)	(4.05)
Age	3.57^{**}	1.94^{**}	−1.20	−1.08	−1.21	−1.34	−0.46	-2.44^{*}
	(1.21)	(0.69)	(2.23)	(2.01)	(1.54)	(1.23)	(1.58)	(1.01)
Constant	−4.72	48.41^{**}	80.16	83.76	124.48^{*}	177.78^{***}	72.55	86.67^{*}
	(41.64)	(17.68)	(73.26)	(65.27)	(53.93)	(43.48)	(45.57)	(37.52)
Treatments	3L	3L	5L	5L	3H	3H	5H	5H
Other Controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,632	1,632	1,700	1,700	1,632	1,632	1,666	1,666
# Clusters	16	16	10	10	16	16	10	10
R^2	0.48	0.41	0.23	0.24	0.30	0.30	0.26	0.24

Note: SE clustered at group level $+\ p < 0.1$; $*\ p < 0.05$; $**\ p < 0.01$; $***\ p < 0.001$

Table 3: Linear regression expected payoff on concealment and controls for different treatments

	Dependent variable:			
	expected payoff			
	(1)	(2)	(3)	(4)
Concealment	-3.82	-0.68	-0.17	0.55
	(3.59)	(4.78)	(1.54)	(1.97)
Round	0.29^{+}	1.19^{**}	0.20^{*}	0.77^{***}
	(0.16)	(0.40)	(0.08)	(0.19)
Risk Aversion	12.13^{***}	0.34	2.76^{**}	0.87
	(3.18)	(1.05)	(0.86)	(2.17)
Loss Aversion	-4.30	-2.63^{+}	0.68	2.28^{+}
	(3.07)	(1.36)	(0.71)	(1.28)
Ambiguity Aversion	3.93^{*}	4.18^{+}	2.21	1.27
	(1.54)	(2.28)	(1.48)	(1.09)
SVO	0.04	0.13	-0.05	-0.15
	(0.40)	(0.35)	(0.10)	(0.27)
Spite	-15.20	11.14	14.88	-37.64
	(18.09)	(25.08)	(9.95)	(26.72)
Female	-3.02	14.94	-0.75	-13.09^{***}
	(5.10)	(9.77)	(2.17)	(2.96)
Age	-5.58^{***}	2.46^{*}	-0.34	2.49^{**}
	(1.54)	(1.11)	(0.55)	(0.76)
Constant	145.54^{***}	16.50	-2.48	-40.58^{*}
	(39.04)	(39.86)	(14.93)	(20.64)
Treatments	3L	5L	3H	5H
Other Controls	✓	✓	✓	✓
Observations	1,632	1,700	1,632	1,666
# Clusters	16	10	16	10
R^2	0.52	0.36	0.36	0.32

Note: SE clustered at group level $+\ p < 0.1$; $^{*}\ p < 0.05$; $^{**}\ p < 0.01$; $^{***}\ p < 0.001$

C.1.4 Robustness Check Group Performance

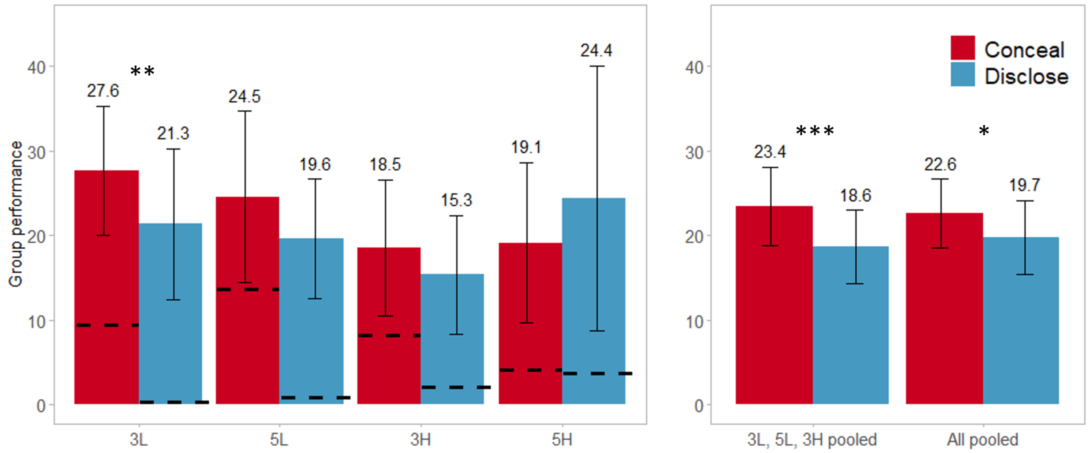

Figure 29: The bar charts show the average group performance conditional on the disclosure policy and on the treatments. The error bars show 95% confidence intervals. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 29 depicts the expected group performance conditional on the disclosure policy for each treatment separately (left panel) and over all treatments pooled, excluding and including treatment 5H (right panel). It shows the averages of the subsets around the policy changes, i.e., rounds 11-20 and 21-30. It confirms the results from the main section in all cases, but in the case of treatment *3H*, where it shows no statistically significant increase under concealment. Linear regressions for the same cases and subset of rounds, show the same significance levels and effects of concealment on the group performance (see table 4).

Table 4: Linear regression group performance on concealment and controls

	Dependent variable:					
	group performance					
	(1)	(2)	(3)	(4)	(5)	(6)
Concealment	7.78^{**}	6.86	4.98	−5.39	3.41^{+}	6.07^{**}
	(2.43)	(4.73)	(3.48)	(3.58)	(1.89)	(2.05)
Round	-0.34^{+}	-0.73^{**}	0.25	0.73^{*}	−0.005	−0.21
	(0.18)	(0.26)	(0.21)	(0.31)	(0.15)	(0.14)
Risk Aversion	−3.92	0.43	−0.74	-2.71^{**}	−0.68	−0.24
	(2.54)	(0.58)	(0.99)	(0.92)	(0.86)	(1.04)
Loss Aversion	2.76	0.95	1.88^{*}	0.28	1.50^{***}	1.62^{**}
	(2.30)	(0.64)	(0.93)	(0.54)	(0.43)	(0.58)
Ambiguity Aversion	−1.39	−0.78	-2.45^{**}	−0.70	-1.79^{*}	-1.73^{+}
	(1.61)	(0.71)	(0.92)	(0.62)	(0.82)	(1.03)
SVO	−0.10	0.01	−0.06	−0.16	0.04	0.004
	(0.31)	(0.11)	(0.13)	(0.29)	(0.12)	(0.14)
Spite	10.36	2.76	-16.09^{***}	19.36^{*}	−0.49	−0.19
	(9.49)	(8.49)	(4.71)	(8.88)	(4.98)	(5.45)
Female	-10.68^{+}	-7.09^{+}	-4.44^{+}	1.09	−1.25	−2.18
	(6.46)	(3.74)	(2.51)	(3.42)	(2.65)	(3.06)
Age	3.33^{**}	−0.54	0.89^{+}	0.33	0.81^{*}	1.12^{*}
	(1.17)	(0.39)	(0.53)	(0.23)	(0.36)	(0.47)
Constant	−38.52	54.06^{***}	−1.53	−5.61	−14.97	−14.04
	(33.11)	(10.90)	(23.84)	(10.36)	(12.37)	(15.08)
Treatments	3L	5L	3H	5H	All	No 5H
Other Controls	✓	✓	✓	✓	✓	✓
Observations	1,632	1,700	1,632	1,666	6,630	4,964
# Clusters	16	10	16	10	52	42
R^2	0.41	0.30	0.18	0.28	0.13	0.19

Note: SE clustered at group level $+\ p < 0.1$; $^{*}\ p < 0.05$; $^{**}\ p < 0.01$; $^{***}\ p < 0.001$

C.1.5 Robustness Check Implemented Choices

In this section, I replicate the main results but by focusing on the choices that were implemented in each round of the experiment. Specifically, this includes only the choices for the realized group size in each round and only by the participants that were chosen to become active in each round. I run several regression analyses with the pre-registered controls,[52] and additionally add the implemented realized group size of the current round as a control. Table 5 shows the regression of the implemented effort, sabotage, and resulting payoffs conditional on concealment, revealing no significant differences between the disclosure policies. Table 6 and table 7 show the same regressions but for each treatment separately. It shows significantly higher sabotage levels under concealment for treatment *3L* and significantly higher effort levels for *5L*. Apart from these significant differences, the regressions do not show any other significant differences in sabotage, effort, or payoffs between the disclosure policies. Finally, table 8 shows the regression of the implemented group performance on concealment and replicates the results from the main section, but other than in the main section, also provides support for a significant increase in group performance for treatment *5L*.

[52] The controls are: being active in the round before, having won in the round before, average sabotage and effort levels of other participants in the rounds before, round, determined group size in the round before, how often won in the rounds before, SVO, spite, risk, loss and ambiguity aversion, age, gender, highest degree, the field of study, the degree of concentration and understanding

Table 5: Linear regression effort, sabotage, and payoffs on concealment and controls for implemented choices

	Dependent variable:		
	effort	sabotage	expected payoff
	(1)	(2)	(3)
Concealment	1.42	2.35^{+}	−1.49
	(1.39)	(1.23)	(1.89)
Round	-0.61^{***}	-0.47^{***}	0.82^{***}
	(0.11)	(0.08)	(0.12)
Risk Aversion	−1.59	−1.17	1.68
	(1.66)	(1.45)	(1.57)
Loss Aversion	−1.31	-1.76^{+}	−1.30
	(0.86)	(0.90)	(1.27)
Ambiguity Aversion	-2.40^{+}	−1.17	1.89
	(1.35)	(1.19)	(1.49)
SVO	0.18	0.11	0.07
	(0.20)	(0.19)	(0.26)
Spite	8.27	18.19^{+}	15.11
	(9.67)	(9.62)	(14.14)
Female	7.66^{*}	6.11^{+}	-10.97^{**}
	(3.48)	(3.20)	(4.22)
Age	0.16	−0.61	−0.51
	(0.64)	(0.53)	(0.83)
Constant	43.48^{+}	61.39^{**}	345.35^{***}
	(22.32)	(21.35)	(28.16)
Treatment Dummies	✓	✓	✓
Group Size Realization Dummies	✓	✓	✓
Other Controls	✓	✓	✓
Observations	3,751	3,751	3,751
# Clusters	52	52	52
R^2	0.18	0.16	0.41

Note: SE clustered at group level + $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 6: Linear regression effort, sabotage, and payoffs on concealment and controls for implemented choices for different treatments

	Dependent variable:							
	effort	sabotage	effort	sabotage	effort	sabotage	effort	sabotage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Concealment	1.73	6.81^{*}	0.68	2.73	0.62	2.63	5.51^{**}	2.22
	(2.83)	(2.74)	(4.05)	(3.82)	(2.62)	(1.84)	(2.02)	(2.37)
Round	-0.62^{**}	-0.48^{*}	-0.36	-0.53	-0.32^{*}	-0.29^{+}	-1.11^{***}	-0.81^{***}
	(0.22)	(0.19)	(0.53)	(0.37)	(0.16)	(0.15)	(0.22)	(0.17)
Risk Aversion	-8.55^{***}	-8.07^{**}	-2.19	-1.94	-6.03^{*}	-7.72^{***}	1.20	1.86
	(2.14)	(2.48)	(1.36)	(1.39)	(2.48)	(1.97)	(3.24)	(2.50)
Loss Aversion	3.77^{+}	2.09	1.66	2.04	-4.73^{**}	-3.46^{+}	-1.93	-3.35^{**}
	(2.23)	(2.84)	(1.36)	(1.44)	(1.55)	(1.78)	(1.34)	(1.14)
Ambiguity Aversion	-2.06	-1.69	-5.31^{**}	-3.95^{*}	-2.93	-1.16	0.17	0.91
	(1.62)	(1.35)	(1.85)	(1.66)	(3.10)	(3.32)	(1.54)	(1.03)
SVO	-0.22	-0.03	-0.36	-0.53^{+}	0.56	-0.02	-0.27	0.04
	(0.37)	(0.25)	(0.34)	(0.31)	(0.34)	(0.31)	(0.45)	(0.44)
Spite	7.56	4.78	13.58	0.27	37.35^{+}	36.68^{**}	-11.52	23.63
	(12.83)	(10.67)	(22.80)	(23.10)	(19.59)	(13.11)	(40.85)	(32.63)
Female	-14.24^{*}	-1.27	0.62	3.75	4.57	-0.65	14.67^{***}	16.01^{***}
	(6.55)	(3.58)	(9.87)	(8.59)	(7.54)	(6.98)	(3.27)	(3.46)
Age	4.33^{**}	1.99^{*}	-1.61	-1.89	-0.84	-0.82	-0.15	-2.31^{*}
	(1.34)	(0.78)	(2.08)	(1.75)	(1.55)	(1.25)	(1.58)	(0.96)
Constant	11.55	69.00^{*}	95.21	108.82^{+}	118.75^{*}	179.86^{***}	69.56	89.37^{*}
	(41.95)	(29.38)	(64.42)	(55.40)	(57.06)	(48.30)	(47.70)	(39.94)
Treatments	3L	3L	5L	5L	3H	3H	5H	5H
Other Controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	713	713	544	544	1,237	1,237	1,257	1,257
# Clusters	16	16	10	10	16	16	10	10
R^2	0.39	0.22	0.20	0.22	0.27	0.27	0.25	0.22

Note: SE clustered at group level $+ p < 0.1$; $* p < 0.05$; $** p < 0.01$; $*** p < 0.001$

Table 7: Linear regression implemented payoff on concealment and controls

	Dependent variable:			
	payoff			
	(1)	(2)	(3)	(4)
Concealment	−1.02	1.28	−2.67	−3.78
	(4.26)	(8.58)	(3.16)	(2.45)
Round	1.03^{**}	0.14	0.52^{*}	0.91^{***}
	(0.39)	(0.79)	(0.22)	(0.18)
Risk Aversion	9.35^{***}	0.51	7.03^{*}	2.47
	(2.33)	(2.36)	(2.73)	(2.74)
Loss Aversion	-5.81^{+}	-5.91^{**}	5.22^{**}	−0.08
	(3.23)	(2.25)	(1.76)	(1.25)
Ambiguity Aversion	2.99^{+}	3.90	5.24	−0.19
	(1.66)	(2.89)	(3.31)	(1.57)
SVO	1.23^{*}	0.53	−0.14	−0.03
	(0.50)	(0.49)	(0.40)	(0.33)
Spite	12.61	46.86	14.28	−10.11
	(23.28)	(39.48)	(18.32)	(24.51)
Female	−4.93	8.41^{*}	−3.34	-18.17^{***}
	(9.84)	(3.95)	(7.49)	(4.62)
Age	-7.62^{***}	2.35^{+}	-2.55^{+}	2.29^{**}
	(1.92)	(1.30)	(1.49)	(0.79)
Constant	348.62^{***}	325.98^{***}	313.77^{***}	324.74^{***}
	(69.24)	(44.88)	(49.81)	(28.59)
Treatments	3L	5L	3H	5H
Other Controls	✓	✓	✓	✓
Observations	713	544	1,237	1,257
# Clusters	16	10	16	10
R^2	0.59	0.50	0.24	0.10

Note: SE clustered at group level $+\ p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 8: Linear regression implemented group performance on concealment and controls

	Dependent variable:					
	group performance					
	(1)	(2)	(3)	(4)	(5)	(6)
Concealment	6.34^{+}	14.84^{*}	7.88^{**}	-7.39^{+}	5.60^{*}	9.51^{***}
	(3.28)	(6.34)	(3.03)	(3.78)	(2.55)	(2.73)
Round	−0.18	−0.34	−0.03	0.59^{+}	0.05	−0.13
	(0.11)	(0.39)	(0.20)	(0.33)	(0.14)	(0.11)
Risk Aversion	−0.31	−0.33	−1.05	-3.26^{***}	−0.73	−0.41
	(1.06)	(0.47)	(0.75)	(0.98)	(0.52)	(0.55)
Loss Aversion	1.40	0.31	2.41^{***}	0.05	0.89^{**}	0.99^{**}
	(1.08)	(0.32)	(0.63)	(0.48)	(0.32)	(0.36)
Ambiguity Aversion	−0.07	−0.22	-1.59^{**}	-1.87^{**}	-0.82^{**}	-0.60^{+}
	(0.42)	(0.52)	(0.55)	(0.64)	(0.31)	(0.34)
SVO	−0.09	0.06	−0.04	−0.15	0.04	0.04
	(0.15)	(0.09)	(0.11)	(0.33)	(0.10)	(0.09)
Spite	8.46	15.03	-8.61^{*}	24.61^{**}	3.53	6.17
	(7.19)	(11.38)	(3.91)	(8.85)	(3.58)	(3.78)
Female	-5.39^{*}	−4.21	−2.01	−1.53	−0.81	−1.62
	(2.59)	(2.61)	(2.04)	(3.64)	(1.53)	(1.33)
Age	0.81	−0.35	0.45	0.11	0.21	0.34
	(0.66)	(0.31)	(0.43)	(0.26)	(0.19)	(0.23)
Constant	1.04	22.97^{*}	13.93	−5.80	−6.13	1.63
	(16.89)	(10.79)	(20.48)	(20.53)	(11.04)	(10.29)
Treatments	3L	5L	3H	5H	All	No 5H
Other Controls	✓	✓	✓	✓	✓	✓
Realized Group Size	✓	✓	✓	✓	✓	✓
Observations	1,632	1,700	1,632	1,666	6,630	4,964
# Clusters	16	10	16	10	52	42
R^2	0.09	0.16	0.13	0.22	0.07	0.09

Note: SE clustered at group level $+\ p < 0.1$; $*\ p < 0.05$; $**\ p < 0.01$; $***\ p < 0.001$

C.1.6 Anticipated Regret

I follow Diecidue & Somasundaram (2017), Loomes & Sugden (1987), Bell (1982) to define regret aversion and then transfer it to the scenario of this paper. Let prospect f be the optimal decision under concealment as a weighted sum over the realized group sizes m, i.e., f_i are the equilibrium choices (and the associated expected utilities in the contest) for a realized group size of $m = i$. Let prospect g be a weighted sum over the realized group size m, but with putting less relevance on the case of $m = 1$, and adding them to the other realized group sizes $m \neq 1$. Regret theory postulated:

$$g \succeq f \Leftrightarrow \sum_{i}^{m} p_i Q(u(g_i) - u(f_i)) \geq 0 \tag{28}$$

I define $u(f_i)$ and $u(g_i)$ as the subjectively believed expected payoffs conditional on the realized group sizes and the chosen prospect. Further, let $u(\cdot)$ be concave in the (expected) payoff. I take p_i as the actual group size probabilities, unlike subjective ones as in the literature. Instead I take the subject's winning probabilities inside of the expected utilities of the prospects. I do this, because the winning probabilities conditional on the group size are affected by the sabotage levels. This would then not admit a direct comparison of the different prospects, conditional on the realized group size (and conditional on winning). By taking the subjective winning probabilities inside of the subjective expected utilities allows for such a direct comparison of the prospect choices and hence allows for feeling regret conditional on the group size realization.

I assume that subjects believe that the highest expected utility is the one from their conditional on the group size choices from part A & C. Hence, they may believe that any deviation from it, is not optimal. Hence, I assume the subjective expected utility to be decreasing in the distance of the choices to their conditional group size choices. If we assume $u(\cdot)$ to be concave in the outcomes (with fixing the equilibrium choices with a linear $u(\cdot)$, as derived in the theory part), and because subjects win the prize $W = 200$ with certainty when alone, a deviation from the optimal decision when being alone does not hurt as much, as for the other group sizes. In other words, the utility loss from being more off in case of a realized group size of one, is lower than the utility gains for the other group sizes:

$$|u(f_1) - u(g_1)| < \sum_{i \neq 1} |u(f_i) - u(g_i)| \tag{29}$$

Equation 29 may be most true in the case of *3L*, as the probability of being the only contestant is very prevalent, and therefore the concealment chocies are farer away from the disclosure choices conditional on the treatment. Therefore, subjects may feel most anticipated regret in this scenario, and hence exchange some small utility losses from less optimal choices if the realized group size is one to increasing their expected payoffs if the realized group size is two or three.

C.1.7 Heterogeneities

Figure 30 shows effort (line 1), sabotage (line 2), received sabotage (line 3), and individual performance (line 4) depending on the rank within a group conditional on the treatments. The rank is based on the exerted effort by group for each round seperately. The figure shows that there are heterogeneities between the group members. The group member that exerts the highest effort also exerts the highest sabotage. Therefore, the group member with the highest effort also receives the least sabotage of the others. This results in a high individual performance for this group member. Therefore, different to theory, less effort is destroyed, as the highest effort group member receives the least sabotage.

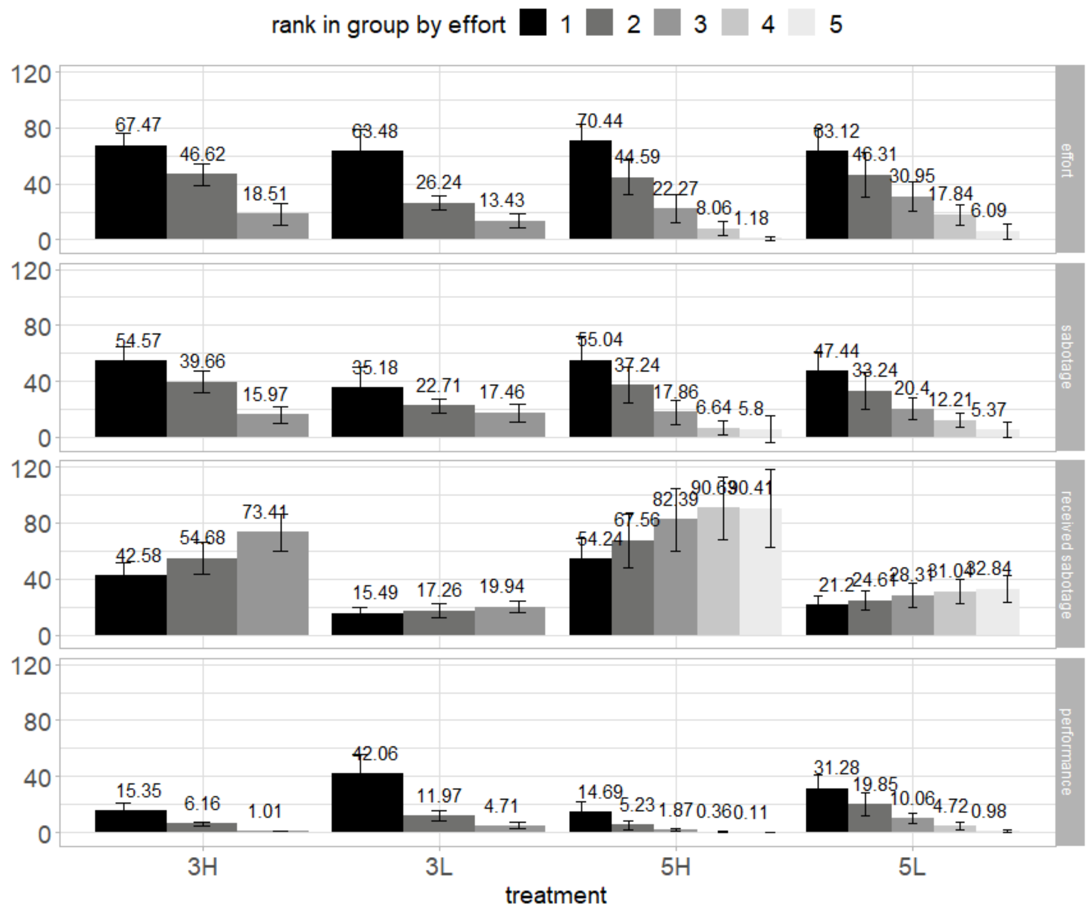

Figure 30: The bar charts show the individual averages based on the rank by effort within a group. The x-axis shows the different treatment, whereas y-axis in the four panels show either effort, sabotage, received sabotage, or the individual performance. The error bars show 95% confidence intervals.

C.2 Known Group Sizes (Group Size Disclosure)

C.2.1 Subsets of Rounds

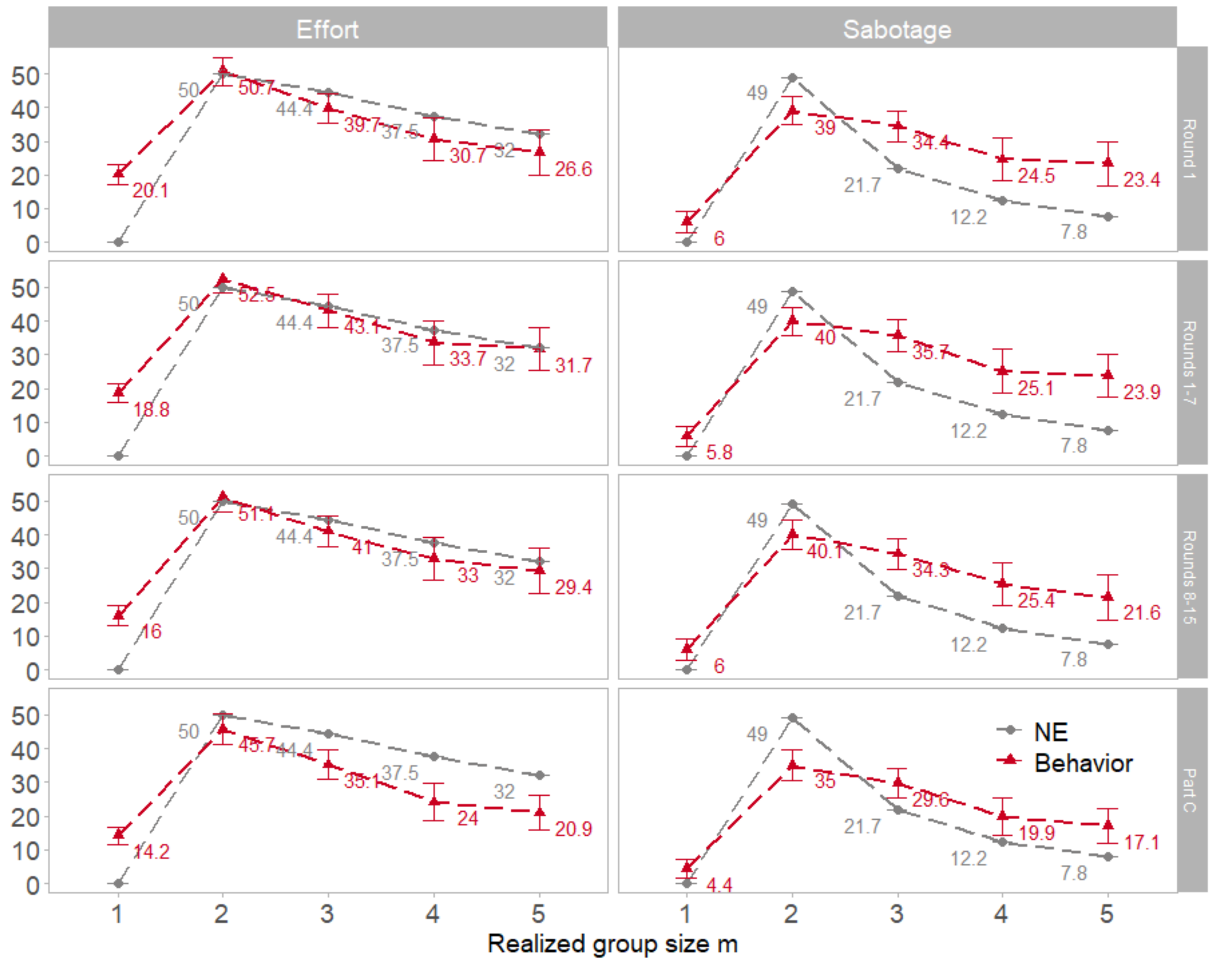

Figure 31: Effort and sabotage levels and Nash equilibria under group size disclosure for the realized group sizes m conditional on a specific subset. Red lines shows the elicited behavior, averaged over the specified subset of rounds Blue lines show the Nash equilibrium predictions. The error bars show 95% confidence intervals.

Figure 31 shows the effort and sabotage levels under disclosure for the realized group sizes conditional on a specific subset of rounds. The first line shows decisions only from the very first round, the second the average from the first part of part A, the third line from the second part of part A, and the fourth from part C.

The effort and sabotage levels are very similar between these subsets of rounds. Importantly, the significant and substantive decrease in effort and sabotage levels for an increase in the group size (except $m = 1$) is very prevalent in all of the panels. Additionally, non-parametric tests show a significant difference between the sabotage (effort) decisions for $m = 2$ and $m = 5$ at a significance level of $p < 0.001$ ($p < 0.001$) in all panels. Moreover, most of the piece-wise comparisons are statistically significant at at least $p < 0.05$.

C.2.2 Time Trends

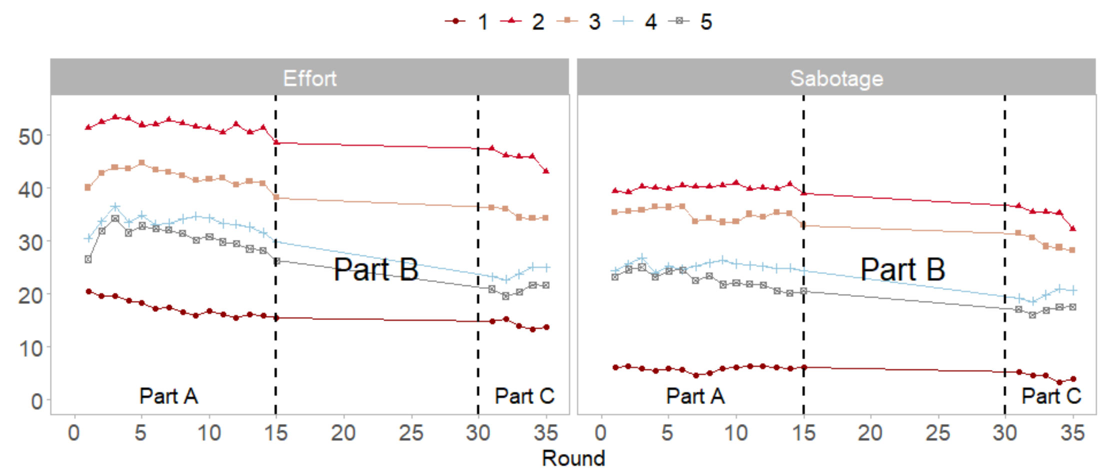

Figure 32: The panels show the time trends for effort and sabotage levels in part A and part C. The vertical line at round 15 indicates the end of part A and the beginning of part C. The colors indicate the average choices for a specific group size.

In this section, I analyze changes in effort and sabotage levels over time. Figure 32 depicts these time trends for parts A and C conditional on the specific realized group size m. Overall, there is a slight decrease in effort and sabotage levels over the rounds. Importantly, the differences between the realized group sizes are not affected by the slight decrease over time – they remain relatively stable over all rounds.

C.2.3 Heterogeneities in Realized Group Size Choices

In this section, I show how heterogeneities in the exertion of effort and sabotage interact with the comparative statics of the realized group size. For this, I classify contestants into either the highest-effort (highest-sabotage) exerting group member of a matching group or the not-highest-effort (not-highest-sabotage) exerting contestants. Figure 33 shows their effort and sabotage levels conditional on the realized group size. It reveals substantive differences in the effort and sabotage levels across these ranks, however, the comparative statics seem to be relatively similar.

C.2.4 Regression Results

Table 9 shows the results of a linear regression with clustered standard errors at the matching group level, where I regress effort and sabotage on the realized group size under group size disclosure (parts A and C). I only include realized group size of $m > 1$, as being alone in the contest ($m = 1$) is a special case. In accordance with the pre-registration, I include the following controls. Individual-level controls: risk

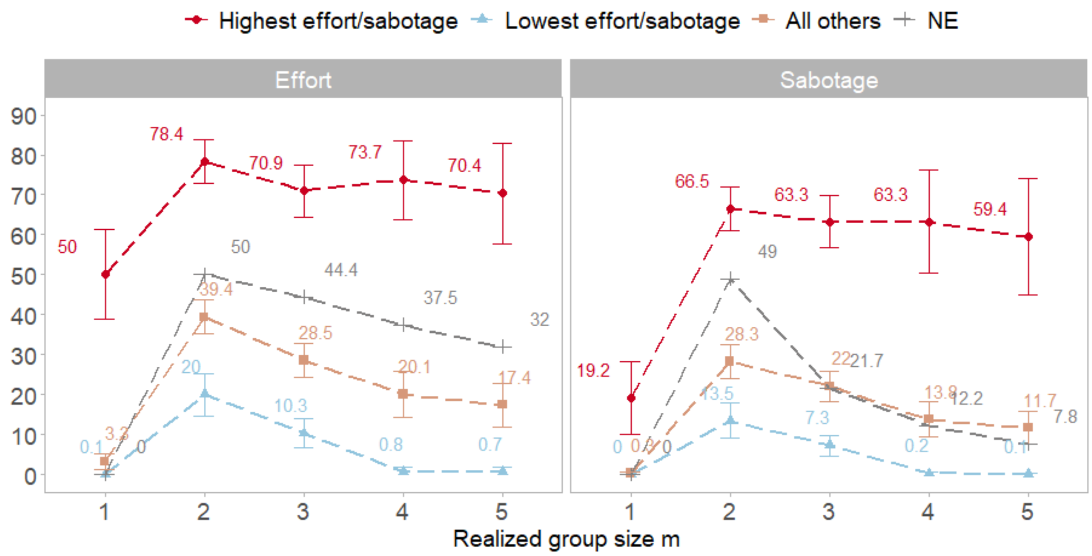

Figure 33: The panel shows effort (sabotage) conditional on being the highest-effort (highest-sabotage) exerting contestant in the matching group.

aversion, ambiguity aversion, loss aversion, SVO, spite, gender, age, highest degree, the field of study, the degree of concentration and understanding. Other controls: round, dummy for part C, being active in the round before, having won in the round before, average sabotage (and effort) decisions of other participants in the round(s) before, determined group size in the round before, and how often won in the rounds before.

Models (1) and (2) confirm the results of the main section and show a significant negative effect of the realized group size on effort and sabotage levels. It further confirms the slight time trend, as round and part C have significant negative effects on effort and sabotage. In model (3), I test for a difference in the steepness of the effect of the realized group size between effort and sabotage levels. It shows that the negative effect of the realized group size is slightly less pronounced for sabotage ($p < 0.1$).

In all models, the spite score has a significant and substantive effect on the elicited choices, showing that subjects with spiteful preferences are more competitive.

Table 9: Linear regression effort and sabotage on realized group size based on part A and part C

	Dependent variable:		
	effort	sabotage	value
	(1)	(2)	(3)
Realized Group Size	-6.36^{***}	-4.77^{***}	-6.29^{***}
	(0.74)	(0.64)	(0.78)
Sabotage			-13.04^{***}
			(2.91)
Round	-0.47^{**}	-0.28^{*}	-0.38^{**}
	(0.16)	(0.13)	(0.13)
Part C	-7.83^{***}	-6.58^{***}	-7.21^{***}
	(1.84)	(1.67)	(1.54)
Risk Aversion	-1.47	-0.15	-0.81
	(1.51)	(1.29)	(1.33)
Loss Aversion	-0.91	-1.59^{+}	-1.25
	(1.12)	(0.87)	(0.97)
Ambiguity Aversion	-2.48^{+}	-1.60	-2.04
	(1.45)	(1.27)	(1.31)
SVO	0.06	0.04	0.05
	(0.18)	(0.18)	(0.16)
Spite	18.67^{*}	29.76^{***}	24.22^{**}
	(9.07)	(8.69)	(8.14)
Female	9.65^{*}	5.43	7.54^{+}
	(4.47)	(4.22)	(4.09)
Age	-0.92	-1.78^{***}	-1.35^{*}
	(0.71)	(0.51)	(0.58)
Realized Group Size:Sabotage			1.44^{+}
			(0.83)
Constant	99.99^{***}	100.46^{***}	106.74^{***}
	(23.93)	(20.68)	(21.67)
Treatment Dummies	✓	✓	✓
Other Controls	✓	✓	✓
Observations	11,172	11,172	22,344
# Clusters	52	52	52
R^2	0.18	0.17	0.17
Note: SE clustered at group level	$+\ p < 0.1$; $^{*}\ p < 0.05$; $^{**}\ p < 0.01$; $^{***}\ p < 0.001$		

C.3 Group Size Uncertainty

C.3.1 Subsets of Rounds

treatment	effort NE	effort levels round 1	rounds 1-7	rounds 8-15
3L	21.53	39.19	36.85	30.17
		(5.01)	(4.36)	(3.81)
5L	32.00	31.78	31.89	27.82
		(4.68)	(5.91)	(4.53)
3H	43.75	44.21	43.58	43.22
		(4.87)	(3.23)	(3.53)
5H	37.66	33.71	32.13	26.43
		(4.97)	(2.65)	(2.21)

Table 10: Average elicited effort in part B by treatment based on different subsets, as well as the Nash equilibrium (NE). Standard errors by group and in round 1 by individual.

treatment	sabotage NE	sabotage levels round 1	rounds 1-7	rounds 8-15
3L	19.17	27.73	29.89	26.29
		(4.09)	(4.81)	(4.03)
5L	25.50	24.74	25.25	22.73
		(4.04)	(4.09)	(3.67)
3H	30.45	36.48	37.45	36.97
		(4.47)	(3.17)	(3.62)
5H	14.36	23.55	25.04	20.67
		(4.05)	(2.87)	(2.10)

Table 11: Average elicited sabotage levels in part B by treatment based on different subsets, as well as the Nash equilibrium (NE). Standard errors by group and in round 1 by individual.

Tables 10 and 11 show average effort and sabotage levels for different subset of rounds. The tables show that both effort and sabotage decrease when the group size increases from 3H and 5H for high enter probabilities, for all shown subsets of rounds. Additionally, non-parametric tests confirm these decreases as significant (at least $p < 0.05$) for all subset of rounds apart from effort in the single round 1 ($p = 0.1994$). Sabotage (effort) decisions are not significantly different between *3L* and *5L* in all shown subsets of rounds.

C.3.2 Time Trends

Figure 34 shows the time trends for part B conditional on the treatments. It shows a slight decrease over time and the treatment differences remain relatively stable across the rounds.

C.3.3 Regression Results

Table 12 shows the results of a linear regression of effort and sabotage on the treatments and controls under group size uncertainty (part B) with clustered standard errors at the matching group level. I split

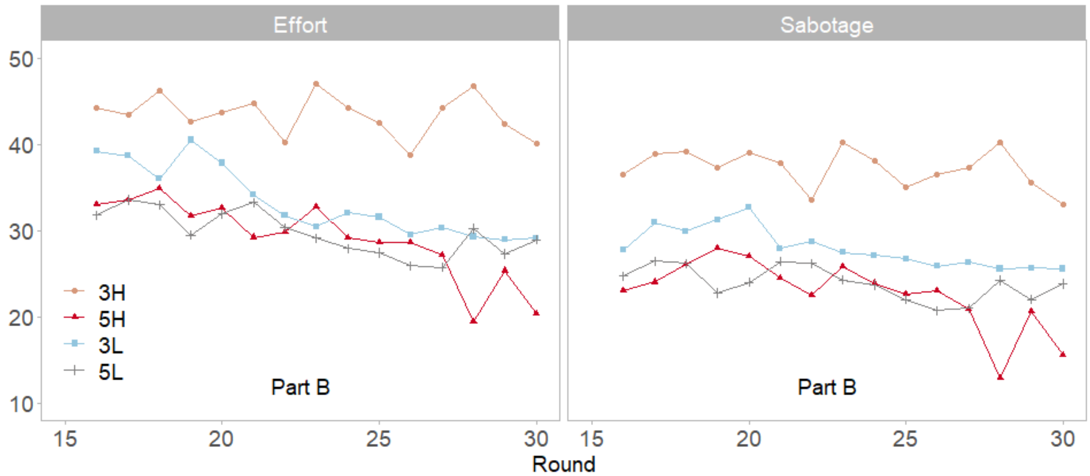

Figure 34: The panels show the time trends for average effort and sabotage levels in part B. The colors indicate the average choices for the specific treatment.

the sample into the treatments with a high enter probability (*3H* and *5H*) and into the treatments with a low enter probability (*3L* and *5L*) as from theory, I expect differential effects depending on the enter probabilities. Models (1) and (2) are based on a sample of treatments *3H* and *5H*, and models (3) and (4) of *3L* and *5L*. Furthermore, in accordance with the pre-registration, I include the following individual-level controls: risk aversion, ambiguity aversion, loss aversion, SVO, spite, gender, age, highest degree, the field of study, the degree of concentration and understanding, and round.[53]

The models confirm the results from the main section. In models (1) and (2), I find a significant decrease in effort and sabotage for Treatment *5H* compared to *3H*. In models (3) and (4), I do not find any significant effect of Treatment *5L* compared to *3L*.

Furthermore, I confirm the negative time trend, as the round variable has a significant negative effect on effort and sabotage in all models. Under high enter probabilities, I find a significant negative correlation between loss aversion and effort and sabotage, and under low enter probabilities, I find a significant negative correlation between ambiguity aversion and effort and sabotage levels.

[53] I do not include the controls of being active in the round before, having won in the round before, average sabotage (and effort) decisions of other participants in the round(s) before, determined group size in the round before, and how often won in the rounds before because they are correlated with the treatments and would take away explanatory power from the treatments.

Table 12: Linear regression effort and sabotage on treatments under group size uncertainty

	Dependent variable:			
	effort	sabotage	effort	sabotage
	(1)	(2)	(3)	(4)
Treatment 5H	-11.69^{***}	-10.82^{*}		
	(3.51)	(4.95)		
Treatment 5L			-3.97	2.73
			(6.13)	(4.31)
Round	-0.52^{**}	-0.41^{*}	-0.62^{***}	-0.33^{*}
	(0.18)	(0.17)	(0.17)	(0.15)
Risk Aversion	-0.84	-0.13	-1.52	-3.59^{*}
	(2.40)	(2.43)	(1.81)	(1.49)
Loss Aversion	-4.08^{**}	-4.35^{***}	2.12	1.71
	(1.26)	(1.15)	(1.48)	(1.44)
Ambiguity Aversion	-0.41	-0.02	-3.75^{*}	-2.97^{**}
	(2.10)	(2.02)	(1.89)	(1.13)
SVO	0.29	0.23	0.03	0.11
	(0.32)	(0.31)	(0.26)	(0.26)
Spite	29.43	34.30^{*}	14.17	5.43
	(18.11)	(16.16)	(14.48)	(11.08)
Female	11.55^{*}	8.24	1.73	5.36
	(4.84)	(5.02)	(6.67)	(6.10)
Age	-0.13	-0.59	0.01	-0.47
	(1.08)	(0.93)	(1.24)	(1.02)
Constant	48.01	62.99^{*}	21.26	51.18
	(33.98)	(29.72)	(36.33)	(34.01)
Treatments	3H, 5H	3H, 5H	3L, 5L	3L, 5L
Other Controls	✓	✓	✓	✓
Observations	1,455	1,455	1,470	1,470
# Clusters	52	52	52	52
R^2	0.20	0.18	0.15	0.21

Note: SE clustered at group level $+\ p < 0.1$; $^{*}\ p < 0.05$; $^{**}\ p < 0.01$; $^{***}\ p < 0.001$