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Working Paper Reducing strategic uncertainty increases group protection in collective risk social dilemmas

Working Papers in Economics and Statistics, No. 2025-02

Provided in Cooperation with: Institute of Public Finance, University of Innsbruck

Suggested Citation: Steimanis, Ivo; Struwe, Natalie; Benda, Julian; Blanco, Esther (2025) : Reducing strategic uncertainty increases group protection in collective risk social dilemmas, Working Papers in Economics and Statistics, No. 2025-02, University of Innsbruck, Research Platform Empirical and Experimental Economics (eeecon), Innsbruck

This Version is available at: https://hdl.handle.net/10419/312922

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Working Papers in Economics and Statistics

2025-02



University of Innsbruck Working Papers in Economics and Statistics

The series is jointly edited and published by

- Department of Banking and Finance
- Department of Economics
- Department of Public Finance
- Department of Statistics

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Reducing strategic uncertainty increases group protection in collective risk social dilemmas

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This version: February 11, 2025

Abstract

Interrelated global crises - climate change, pandemics, loss of ecosystem services and biodiversity - pose risks that demand collective solutions. Uncertainty about others' behavior, coupled with the dependence on some to take collective efforts to mitigate risks for all (e.g. conservation of natural habitats by those living at wildlife boarders to reduce risk of zoonoses), complicates collective action. We extend the experimental collective risk social dilemma to consider that some individuals ('beneficiaries') cannot protect themselves and must rely on others ('providers') for collective protection. Our approach allows to disentangle the relevance of self-interest and uncertainty over the actions of others in explaining self-reliance by providers. Our findings show that reducing strategic uncertainty leads to more collective solutions, with more beneficiaries protected, less resources wasted, and lower inequality. Moreover, we show that institutions inspired by payments for ecosystem services that allow beneficiaries to make compensation transfers to providers of protection are highly effective in fostering collective solutions. Indeed, these voluntary institutions are similarly effective in alleviating the social dilemma as (the hypothetical case of) fully removing strategic uncertainty. Thus, we show that understanding the reasons for self-reliance in collective risk social dilemmas can help develop better institutions to enhance the use of collective solutions, and thereby enhancing social welfare.

JEL: D70; H41; C92; D64; Q54

Keywords: Collective risk social dilemma, cooperation, mitigation, adaptation, strategic uncertainty, selfinterest, public good, donation, laboratory experiment

Acknowledgements: This study was pre-registered at https://aspredicted.org/SXY_YVF and has received IRB Approval from the Board for Ethical Questions in Science of the University of Innsbruck (02/2023). Financial support from the Austrian Science Fund (Grant P-32859 and SFB F63) is gratefully acknowledged. We thank participants at the 7th Workshop on the Ostrom Workshop (WOW7), 20th International Conference on Social Dilemmas, 29th Annual Conference of the European Association of Environmental and Resource Economists, and seminar participants at the Ostrom Workshop's Research Series at Indiana University, Bloomington for their helpful comments. We are most grateful to James M. Walker for discussions on the conceptual development of the framework enabling the removal of strategic uncertainty. We thank Carina Wohlschlager and Sophia Gschwendtner for their exceptional research assistance in running the laboratory experiments.

1. Introduction

The climate crisis and the ecological emergency, with their associated losses in ecosystems, biodiversity and wildlife habitats, entail significant pressure on sustained human and planetary well-being (IPCC, 2023). These are examples of so-called large scale collective action problems (Jagers et al., 2020). There exist measures to individually protect against the adverse effects of these phenomena (private adaptation, which we refer to in the following as "individual solutions"). Examples of such measures include waterproofing one's home against the increasing occurrence of flooding, or getting private health insurance in the face of the increasing likelihood of pandemics due to zoonotic disease outbreaks. At the same time, collective efforts such as mitigation and collective adaptation against collective risks are public goods that indiscriminately generate higher overall well-being for all (referred to herein as "collective solutions"). For the adverse impacts mentioned above, these could be, for instance, restoring riverbanks to manage flooding risk or conserve natural habitats to decrease the spread of zoonoses. Behavioral sciences can improve our understanding of people's preferences and behavioral responses to these collective risks social dilemmas, which is crucial in order to better inform policy design.

Along these lines, previous experimental literature has focused on understanding the behavioral drivers for avoiding collective risks, considering the role of variations in the size of damages (Blanco et al., 2017; Blanco et al., 2016), in institutional arrangements (Barrett & Dannenberg, 2016, 2022; Milinski & Marotzke, 2022; Milinski et al., 2006), heterogeneity in damages and wealth (Burton-Chellew et al., 2013; Lippert & Tremewan, 2021; Milinski et al., 2011; Tavoni et al., 2011; Vasconcelos et al., 2014), uncertainties over the size of damages and over thresholds of cooperation to avoid the collective loss (Barrett & Dannenberg, 2012, 2014; Gangadharan & Nemes, 2009; Milinski et al., 2008), and gradual risk mitigation (Blanco et al., 2020; McEvoy et al., 2022), among others. At the same time, a second branch of the literature considers how the additional availability of individual solutions to collective risk social dilemmas affects people's willingness to invest into avoiding the collective risks (Gross & Böhm, 2020; Gross & De Dreu, 2019; Gross et al., 2020). Results from these studies show that individuals prefer more expensive individual solutions over collective solutions. Despite not being social welfare efficient, individuals rather rely on themselves and avoid depending on others so as to not risk experiencing losses if others are not sufficiently cooperating to protect against the collective damage. In particular, when the individual solution becomes cheaper relative to the collective solution, the likelihood of reaching a collective solution decreases (Gross & De Dreu, 2019). Similarly, wealth asymmetries undermine social welfare and increase inequality between group members in a similar setting (Gross et al., 2020), and given the opportunity, groups choose to abolish individual solutions to shared problems, increasing cooperation and decreasing inequality (Gross & Böhm, 2020). Blanco et al., 2020 and McEvoy et al., 2022 also investigate how the availability of individual alternatives affects investments into collective solutions by considering continuous reductions in collective risks without a safe threshold. This branch of studies provides valuable insights into the significant obstacles that the availability of private solutions poses for collective investments in risk reduction. However, these studies cannot disentangle the distinct roles of self-interest and aversion to strategic uncertainty in driving reliance on private solutions, as both factors would result in equivalent behavior. Identifying these underlying factors is crucial to design policy interventions that effectively promote collective solutions to shared challenges.

Our study addresses this gap by isolating the role of strategic uncertainty in influencing collective action in the face of shared risks. We extend the collective risk social dilemma with collective and private solutions (Gross & Böhm, 2020; Gross & De Dreu, 2019; Gross et al., 2020), incorporating situations in

which some, but not all, individuals affected by the collective risk can take active protective measures for themselves and others. We introduce a strong asymmetry among group members regarding their available actions to address the problem: some members (hereafter referred to as 'providers') have the ability to protect both themselves and others, while others ('beneficiaries') depend on the efforts of the providers for protection (e.g. for technical, geographical or institutional constraints). We are inspired by the observation that the benefits of collective measures often extend beyond those providing them and bearing their cost (Tompkins & Eakin, 2012). For example, under the French Flood Prevention Action Plan, rural landholders voluntarily allow their properties to be flooded in case of high waters, and thus reduce vulnerability to flooding in more densely populated urban areas downstream (Erdlenbruch et al., 2009). Similarly, the actions of those living at the edge of wilderness areas - for example less hunting and consumption of wild meat - reduce the risks of zoonotic disease outbreaks for everyone. This does not imply that beneficiaries have not capacity at all in helping to address the collective risk. There exist voluntary institutional arrangements that allow them to make monetary transfers in the form of donations to incentivise and financially compensate providers. Typically this is mediated by charitable organizations, such as non-governmental organizations (NGOs), acting as the intermediaries between providers and beneficiaries. A prominent application of such programs are Payments for Ecosystem Services (PES) that constitute a widely adopted policy instrument for climate adaptation and mitigation, as well as the conservation of water, forests and biodiversity (e.g. Chichilnisky & Heal, 1998; Ferraro, 2011; Ferraro & Kiss, 2002; Kinzig et al., 2011), mobilizing 36-42 billion US dollars annually as of 2018 (Salzman et al., 2018).

We study the role of strategic uncertainty in the provider-beneficiary collective risk social dilemma in an experiment (n = 400), see Figure 1. A group is faced with a shared collective risk, whre beneficiaries (orange) are completely dependent on providers (green) to solve the shared problem. Providers decide individually how many points they want to invest into a private pool or into a public pool, keeping the remaining resources for themselves. Each provider must either reach the private solution at a cost c_i or cooperate with other providers in order to reach the collective solution at a collective cost c_p , in order to avoid losing the points they did not invest into either pool. If the collective solution is implemented, all group members (providers and beneficiaries) are protected from the collective risk. We test four treatment conditions systematically varying the extent of strategic uncertainty (Panels A-D in Figure 1). Each treatment consists of two parts, with 5 decision rounds in Part 1 and 10 decision rounds in Part 2. In the control condition (*Control*, n = 20 groups, Panel A), the three beneficiaries remain passive throughout both Part 1 and Part 2 and fully rely on the three providers to protect their resources by implementing the collective solution. This situation constitutes a social dilemma, since social welfare is maximized when the collective solution is reached, but both selfishness and high withingroup strategic uncertainty might induce providers to rely on private protection (which is both cheaper and safe, shielding them from free-riding of other providers).



Figure 1: Experimental Design for the collective risk social dilemma with providers and beneficiaries

Note: Providers can protect themselves from the shared problem individually, by investing enough resources in their individual private pool to reach the threshold c_i , or collectively. If providers together invest enough resources into the public pool and reach the threshold c_p , all group members, including beneficiaries, are protected. If neither threshold c_i nor c_p is reached, the provider loses their remaining endowment $w - c_i - c_p$. Notice that $c_i < \frac{1}{n_I}c_p$, meaning that it is cheaper for an individual provider to protect themselves than to invest the fair-share into the collective solution. From the group perspective, the socially efficient outcome is reached with the collective solution, as beneficiaries resources are also protected. This makes the beneficiaries-providers collectively protected against losses is motivated by minimal costs of private adaptation measures (water-proofing one's house), or the minimal collective efforts needed to reach herd immunity or avoid a catastrophic ecosystem tipping point (Lenton, 2013).

Building on the *Control* treatment, we next consider two treatments that reduce both within and between group strategic uncertainty by introducing voluntary institutions, *Proportional* (n = 20 groups, Panel B) and *Pledges* (n = 20 groups, Panel C). Both treatments first start with passive beneficiaries in Part 1 of the experiment (rounds 1-5), and then introduce institutions enabling beneficiaries to offer transfers to providers in Part 2 (rounds 6-15), which are shared proportionally among them depending on their relative contributions to the collective solution. The proportional redistribution of transfers incentivizes cooperation as it provides a monetary incentive for providers to invest in the public pool. This occurs because providers receive a larger share of transfers as their contribution to the collective solution increases, all else being equal (see Supplementary Materials section B for the formal details). Consequently, beneficiaries are motivated to offer sufficient transfers to induce providers to invest enough to reach the threshold c_p and, thus, protecting everyone through the collective solution. The proportional sharing of transfers aligns incentives within and across providers and beneficiaries, thereby reducing strategic uncertainty. As a consequence, we expect that the frequency with which providers establish the collective solution will, on average, be higher in the *Proportional* than in the *Control* treatment. This

hypothesis is further supported by previous evidence on the efficiency of proportional arrangements in provider-beneficiary dilemmas involving linear deterministic public goods (Blanco et al., 2021; Struwe et al., 2024). In addition, in *Pledges*, both providers and beneficiaries make non-binding numeric pledges regarding their intended behavior to the other providers and beneficiaries respectively, before making their investment and transfer decisions. This communication device has been shown to be effective in alleviating strategic uncertainty and leading to higher levels of cooperation in social dilemma situations (see, for example, Barrett & Dannenberg, 2016; Bochet et al., 2006; Bochet & Putterman, 2009; Denant-Boemont et al., 2011; Koessler, 2022; McEvoy et al., 2022; Pogrebna et al., 2011; Tavoni et al., 2011). This leads us to expect that the frequency with which providers establish the collective solution will, on average, be higher in the *Pledges* condition compared to both *Control* and *Proportional*, and that average transfers from beneficiaries will be significantly higher in *Pledges* compared to *Proportional*.

Finally, in *Single P-B* (Panel D), we eliminate within-subgroup strategic uncertainty by collapsing group size to a single provider and a single beneficiary. In Part 1 of this treatment the single beneficiary is passive, whereas in Part 2, they can make a direct transfer to the single provider. Importantly, the implementation of the collective solution by the single provider in this treatment is deterministic and does not depend on cooperativeness of others. The resulting absence of strategic uncertainty in this treatment allows us to isolate the role of self-interest in hindering cooperation and therefore identify the added effect of strategic uncertainty in the treatments where it is present. We expect that the frequency with which providers establish the collective solution will already be higher in Part 1 in the *Single P-B* condition compared to the other treatments, and that average transfers in Part 2 will also be higher. The situation we consider in *Single P-B* can be seen as a constructed, hypothetical "benchmark" scenario where strategic uncertainty is absent, allowing us to isolate prosocial and self-interested motivations from strategic uncertainty, which is not feasible in field conditions. The laboratory approach therefore allows us to understand the effectiveness of field-relevant institutions (as considered in *Proportional* and *Pledges*) in alleviating the collective risk social dilemma and promote a behavioral shift towards collective solutions against such a hypothetical benchmark scenario.

To estimate the causal effect of eliminating strategic uncertainty among providers on how the shared risk is dealt with, we first analyse how reducing the group size from three providers and three passive beneficiaries (all identical treatments pooled in Part 1: *Control, Proportional,* and *Pledges*) to a single provider and passive beneficiary (*Single P-B*) affects resource investment in collective and individual solutions by providers. Next, we analyze how the introduction of voluntary transfer institutions in Part 2 affect resource investments by providers into the collective and the private solution across treatments. We use a difference-in-difference (DiD) estimation approach to identify the causal effect of introducing the voluntary transfer institutions by accounting for pre-treatment (Part 1) differences across groups that occurred by chance and time trends related to the cooperativeness of groups in later rounds, see Figure 3, panels E to G. Finally, we explore effects on welfare, resource waste, and inequality.

2. Results

Increasing reliance on collective solutions

Eliminating strategic uncertainty increases the use of the collective solution. In the absence of transfers (Part 1), the collective solution was established 48% of times by the providers in the *Single*

P-B treatment, as compared to 11% of times in the conditions three providers (see Figure 2 panel A). That is, the absence of strategic uncertainty among providers leads to an increase of 37%-points in the frequency with which the collective solution is implemented (p-value < 0.005, 95% CI = 22.05, 52.61). This occurs even though average contributions to the collective solution are well below the 40% fair-share, irrespective of whether groups of providers (18.2% \pm 14.5) or a single provider (22.5% \pm 21.9) made contribution decisions (T-Test contributions = 40%, p-values < 0.005). Contributions do not differ significantly across treatment conditions ($\beta = 4.3$, p-value = 0.25,95% CI = -3, 11.56). This occurs, as in the (*Single P-B*) the provider's can solve the problem alone are not exposed to the risk that other providers not contribute enough to reach the collective threshold.

Provider's reliance on the individual solution to deal with the shared risk in Part 1 is reduced from 74% of self-reliance among groups of providers to 62% in *Single P-B* ($\beta = -12$, p-value = 0.08,95% CI = -25.47, 1.47).



Figure 2: Effect of eliminating strategic uncertainty through group size reduction

Note: The figure shows the main behavioral outcomes across conditions that differ in Part 1 (panel A): the frequency with which the threshold for the collective solution c_p is reached in %, (ii) providers individual contributions g_{Pi} to G in % of endowment, and (iii) the frequency with which the threshold for the individual solution c_i is reached in %. The dashed-lines indicate 95% confidence intervals around the means. Panel B shows point estimates and confidence intervals (90% and 95%) of differences between conditions in Part 1 from multilevel regression modelling with random effects at the group and subject level to account for the nested structure of the data. The main independent variable is a binary treatment dummy, taking the value 0 in for all treatments that are the same in Part 1 (Control, Proportional, Pledges) and 1 for the Single P-B treatment. See Supplementary Materials Table S3 for the full regression outputs and robustness checks excluding providers in Single P-B who showed understanding issues. All results are qualitatively robust to excluding these observations. Stars indicate significance levels: * p < 0.10, ** p < 0.05, *** p < 0.005

Institutions reducing strategic uncertainty increase the use of the collective solution. The collective solution is most often implemented among providers in the *Single P-B* treatment (in 62% of cases), followed by *Pledges* (51%), *Proportional* (39%), and *Control* (17%), see Figure 3 Panel A. Providers' contributions to the collective solution are closer to their "fair share" in both *Pledges* (34%) and *Proportional*

(33%), but still well below it. This is the case despite transfers, especially in *Single P-B* with 26% (T-Test contributions = 40%, all p-values < 0.005, Figure 3 Panel B). In terms of self-reliance by providers (Figure 3 Panel C), we find that this is lowest in *Single P-B* (47%) and *Pledges* (49%), followed by *Proportional* (57%) and lastly *Control* (80%). Thus, providers seem to shift resources, at least to some degree, from the individual to the collective solution in response to the transfer institutions.

How much do beneficiaries transfer when they are allowed to do so in Part 2? We see that beneficiaries voluntarily make substantial use of transfers in all treatments. On average, transfers amount to 26% of endowment in both *Proportional* and *Pledges* (non-significant difference between the two: $\beta = -0.59$, p-value = 0.78, 95CI = -4.89, 3.71, see Figure 3 Panel D) and 20% of endowment in *Single P-B* (significantly lower compared to both *Proportional* p-value = 0.02 and *Pledges* $\chi^2(1) = 0.04$, p-value = 0.01, see panel D). In line with the formal predictions (Supplementary Materials section B), beneficiaries transfer more than the indicated "fair share" of 20% of their endowment to compensate providers' efforts and risks inherent to solving the shared problem collectively.

Introducing voluntary transfer institutions increases the use of the collective solution to the same extent than having a single provider and single beneficiary. In both *Proportional* and *Pledges*, provider's response to the introduction of transfer institutions is substantial (Figure 3 panel E). We find large increases in the reliance on the collective solution due to transfers, with a 26%-points increase in *Proportional* as compared to *Control* (DiD estimate T1*Part2: p-value < 0.005, 95 % CI= 8.93, 43.07) and a 37.5%-points increase in *Pledges* as compared to *Control* (see DiD estimate T2*Part2: p-value < 0.005, 95% CI= 23.75, 51.25). Allowing for pledges in addition to transfers by beneficiaries does not significantly increase the reliance on the collective solution (DiD estimate T1*Part2 vs T2*Part2: diff. = 11.5, $\chi^2(1) = 1.37$, p-value = 0.24). This indicates that the improvement in cooperation is primarily due to the introduction of proportionally shared transfers. The introduction of transfers in *Single P-B* does not result in a significant increase in the implementation of the collective solution (net of any existing Part 1 differences observed with *Control*, see DiD estimate T3*Part2: $\beta = 10.5$, p-value = 0.27, 95% CI = -8.14, 29.14). That is, the higher likelihood of implementing the collective solution in Part 2 of *Single P-B* compared to *Control* is primarily due to the reduced group size and associated absence of strategic uncertainty for providers (Part 1 effects) and not due to beneficiary's transfers.

Importantly, we observe that voluntary transfer institutions are as effective in increasing the reliance on the collective solution as fully removing strategic uncertainty. Specifically, the increase in the frequency with which the collective solution was implemented due to proportional transfers in both *Proportional* and *Pledges* (DiD estimates, net of any pre-treatment trends as compared to *Control*) is statistically not different from the increase in collective solutions obtained from comparing a single provider to a group of providers void of transfers in Part 1 (that is, we compare the Part 1 treatment effect of *Single P-B* to the DiD estimates T1*Part2: $\chi^2(1) = 0.04$, p-value = 0.83; and T2*Part2: $\chi^2(1) = 0.048$, p-value = 0.49).

Relative to *Control*, all three treatments that allow for transfers induce providers to shift resources from the individual to the collective solution. Contributions to the collective solution increase between 9 and 23%-points (all DiD estimates in panel F, p < 0.05), while self-reliance goes down between 25 and 34%-points (all DiD estimates in panel G, p < 0.005). The relative reduction in self-reliance does not significantly differ between treatments with transfers (difference in DiD estimates T1*Part2 vs T2*Part2, p-value = 0.81; T2*Part2 vs T3*Part2, p-value = 0.49; and T1*Part2 vs T3*Part2, p-value = 0.37).



Figure 3: Effects of voluntary transfer institutions on collective and private solutions

Note: Panels A to D show the main behavioral outcomes across treatments in Part 2: likelihood that the collective solution is reached (panel A), contributions to the collective solution (panel B), share of providers opting for the individual solution (panel C), and beneficiaries transfers (panel D). The dashed-lines indicate 95% confidence intervals around the means. The "fair share" indicated by the dashed line in panel B shows the equal cost-sharing amount each provider would need to contribute to reach the collective threshold. Similarly, the fair share in panel D indicates the amount beneficiaries would need to transfer to providers to compensate them for trying to reach the collective threshold. Panel E to H show point estimates and confidence intervals (90% and 95%) from multilevel regression modelling with random effects at the group and subject level to account for the nested structure of the data. The main independent variables in the models are the treatment dummies and 'Part 2', a dummy variable taking the value '0' in Part 1 and '1' in Part 2, as well as the interaction of both to obtain the DiD estimates. For panels E to G, we plot the DiD estimates, while for panel H we plot the treatment estimates for Part 2 (DiD estimates are not available as transfers were only introduced in Part 2). See Supplementary Materials Table S4 for the full regression outputs and Table S7 for robustness checks using multilevel logit regressions. All results are qualitatively robust to the different modeling specifications. In addition, in Supplementary Materials C we provide a detailed descriptive discussion of the data: For a graphical overview of all outcomes in each treatment across all 15 decisions rounds see Supplementary Figure S5. In Figures S7 to S10, we graphically show the evolution of contributions to the collective solution and transfers over rounds for each group in each treatment separately. See also Figure S6 for the distribution of individual contributions to the public pool in each of the four treatments. Stars indicate significance levels: * p < 0.10, ** p < 0.05, *** p < 0.005

In supplementary section D.2 we provide in addition analyses of treatment effects on expectations rather than actual behavior. In Part 1, beneficiaries in *Single P-B* expect providers to contribute 6.5 points less to the collective solution than in other treatments (p-value = 0.018), with no significant differences

in expectations for private solution investments ($\beta = -0.92$, p-value = 0.8). DiD estimates indicate that introducing a voluntary transfer institution also raise beneficiaries' expectations about providers' contributions to the collective solution by 14 to 17 points (*Proportional*: $\beta = 17.14$, p-value < 0.0001; *Pledges*: $\beta = 14$, p-value < 0.0001; *Single P-B*: $\beta = 17.22$, p-value < 0.0001), while expectations for private solution investment significantly decrease (*Proportional*: $\beta = -6.74$, p-value = 0.013; *Pledges*: $\beta = -7.65$, p-value = 0.008; *Single P-B*: $\beta = -10.96$, p-value = 0.003). Providers in *Single P-B* also have significantly lower expectations of transfers from beneficiaries compared to *Proportional* ($\beta = -12.96$, p-value < 0.0001 and *Pledges* ($\chi^2(1) = 12.47$, p-value = 0.0004.

Additional results on determinants of behavior show a reciprocal response from providers to the decisions of beneficiaries in both the *Proportional* and the *Single P-B* decision setting. Specifically, deviations from expected transfers as well as the share of received transfers positively affect contributions to the collective solution. This relationship does not appear in the *Pledges* treatment, where providers respond rather to deviations from other providers' pledges and actual behavior (see Tables S11 and S12 in the Supplementary Materials). Notice that on average pledges deviate by 5.4 points from actual contributions (see Figure S12 for evolution of actual contributions, transfers, pledges, and expectations). Further, we find evidence of a negative reciprocal response of beneficiaries to the group of providers having established the collective solution by reducing future transfers, and a positive reciprocal response when interacting instead with a single provider. We find further evidence that beneficiaries positively and significantly react to the transfer pledges of other beneficiaries (Tables S13 and S14), despite the fact they to pledge on average 6.5 points more than they actually transfer (see Figure S12 Panel B).

Secondly, evidence from a post-experimental questionnaire shows that providers' self-reported selfinterest as well as motivations for social efficiency correlate significantly with contributions to the collective solution only in the *Single P-B* treatment. Mistrust towards the other providers in a group does not correlate with contributions toward the collective solution, despite providers reporting relatively high frequencies of this motivation in *Control, Proportional* and *Pledges* (about 60%). All details of these additional results are included in the Supplementary Materials D.4.

Exploring treatment effects on welfare, resource waste, and inequality

A single provider and beneficiary increase welfare of beneficiaries while reducing resource waste and inequality, see Figure 4. Eliminating strategic uncertainty through group size reduction in Part 1 benefits the welfare of the single beneficiary in *Single P-B* compared to treatments with groups of beneficiaries. Beneficiaries in *Single P-B* earn 48 points on average compared to the 11 points in the other conditions ($\beta = 37.3$, p-value < 0.005, 95% CI = 22.05, 52.61), whereas providers in *Single P-B* are not significantly better off ($\beta = 6.2$, p-value = 0.21, 95% CI = -3.53, 15.92). Further, resource waste with 37% and inequality with a Gini of 33 are lower when strategic uncertainty is eliminated. The increase in beneficiary earnings goes hand-in-hand with a significant reduction of both resources wasted ($\beta = -27.21$, p-value < 0.005, 95% CI = -36.06, -18.35) and inequality ($\beta = 24.96$, p-value < 0.005, 95% CI = -30.49, -19.44) in *Single P-B*.



Figure 4: Effect of reducing group size on welfare, resource waste, and inequality

Note: Panel A shows averages in Part 1 of providers round payoff in points pi_i , beneficiaries round payoff in points pi_j , resources wasted in % defined as total group payoffs deviation from social optimum, and within-group inequality measured by the Gini coefficient where a value of 0 indicates perfect equality and a value of 100 maximal inequality. The dashed-lines indicate 95% confidence intervals around the means. Panel B shows estimates of differences between conditions in Part 1 from multilevel regression modelling with random effects at the group and subject level to account for the nested structure of the data. The main independent variable is a binary treatment dummy, taking the value 0 for all treatments that are the same in Part 1 (Control, Proportional, Pledges) and 1 for the Single P-B treatment. See Supplementary Materials Table S5 for the full regression outputs and robustness checks excluding providers in Single P-B who showed understanding issues. All results are qualitatively robust to excluding these observations. Stars indicate significance levels: * p < 0.10, ** p < 0.05, *** p < 0.005

Concerning providers' and beneficiaries' earnings, resources wasted and inequality, on average across all rounds in Part 2, the *Single P-B* treatment performs best, followed by *Pledges*, *Proportional*, and *Control* (see Figure 5 panel A to D for absolute differences across treatments in Part 2). Specifically, the *Single P-B* treatment leads to the highest earnings per round for both beneficiaries (77 points) and providers (47 points), least resources wasted (22%), and lowest inequality (Gini coefficient of 21). Putting these numbers into perspective by comparing them to *Control*, we find a 40% increase in earnings for providers, almost 3 times more earnings for beneficiaries, 60% less resources wasted, and 2.4 times lower inequality.

Introducing a voluntary transfer institution with non-binding pledges increases welfare and reduces resource waste and inequality. Turning to the relative performance increases accounting for differences in Part 1 across treatments (Figure 5, panel E to H, DiD estimates), the *Pledges* institution significantly increase earnings for both providers (interaction $\beta = 10.86$, p-value < 0.005, 95% CI= 3.98, 17.74) and beneficiaries (interaction $\beta = 23.52$, p-value < 0.005, 95% CI= 11.48, 35.56). Higher earnings imply that groups move closer to the social optimum, which is reflected in 21%-points fewer resources wasted (DiD estimate $\beta = -21.49$, p-value < 0.005, 95% CI= -30.57, -12.41) and a 17%-points decrease in inequality (Did estimate $\beta = -16.77$, p-value < 0.005, 95% CI = -13.37, -8.88). The *Pledges* treatment performs significantly better than the *Proportional* in terms of providers' earnings

 $(\chi^2(1) = 10.6, \text{p-value} < 0.005)$, resource waste ($\chi^2(1) = 4.6, \text{p-value} = 0.03$), and inequality reduction ($\chi^2(1) = 2.88, \text{p-value} = 0.09$).

On the other hand, we observe that the *Proportional* treatment does not significantly affect providers' earnings (p-value = 0.78), which could be explained by the fact that they already earned more in Part 1 than providers in *Control* ($\beta = 8.46$, p-value= 0.01, 95% CI= 1.94, 14.96) despite the decision environment being the same. While beneficiaries in *Proportional* earn about 14 points more per round when transfers were introduced (DiD estimate: $\beta = 14.57$, p-value=0.05, 95% CI= -0.27, 29.41), we find insignificant reductions in inequality within groups ($\beta = -7.48$, p-value= 0.12, 95% CI= -16.81, 1.85) and in resources being wasted ($\beta = -8.56$, p-value= 0.10, 95% CI= -18.79, 1.66). It is worth noting that this does not imply that the true effect is necessarily zero. Indeed, the confidence intervals mostly include values that indicate a large and meaningful reduction in both waste and inequality in *Proportional*.

In Single P-B, allowing beneficiaries to make transfers to providers mainly works as a redistributive mechanism by benefiting only the earnings of providers (DiD estimate panel E: $\beta = 13.21$, p-value < 0.005, 95% CI = 5, 21.41) but does not further increase earnings of beneficiaries (panel F) nor reduces resource waste (panel G) and inequality (panel H) further than what was obtained from group size reduction in Part 1 as discussed above.



Figure 5: Effect of voluntary transfer institutions on welfare, resource waste and inequality

Note: Panels A to D show averages in Part 2 of providers round payoff in points pi_i , beneficiaries round payoff in points pi_j , resources wasted in %, and Gini coefficients (0-100). The dashed-lines indicate 95% confidence intervals around the means. Panel E to H show coefficient plots from multilevel regression modelling with random effects at the group and subject level to account for the nested structure of the data. The main independent variables in the models are the treatment dummies and 'Part 2', a dummy variable taking the value '0' in Part 1 and '1' in Part 2, as well as the interaction of both to obtain the DiD estimates. For panels E to H, we only plot the DiD estimates which identify the causal effect relative to the *Control*. See Supplementary Materials Table S6 for the full regression outputs. Stars indicate significance levels: * p < 0.10, ** p < 0.05, *** p < 0.005

3. Discussion

We provide experimental evidence that reducing strategic uncertainty among public good providers in collective risk social dilemmas increases cooperation to avoid collective damages. In settings where only some (providers) are capable of contributing to collective and private solutions to the collective risk, while others (beneficiaries) are dependent on them, we consider three treatment conditions that progressively reduce strategic uncertainty. Compared to a control setting with passive beneficiaries, we firstly test the effectiveness of a mild reduction of strategic uncertainty by allowing beneficiaries to compensate providers through monetary transfers proportional to their collective risk mitigation efforts. Secondly, we test a medium reduction by allowing non-binding numeric pledges as commitment and coordination devices within members of each subgroup in addition to proportional transfers. Finally, we

consider a complete elimination of strategic uncertainty by comparing groups with the minimal size of one provider and one beneficiary to the control setting. All treatments significantly improve cooperation and the proportion of efficient outcomes, with more protected beneficiaries, less resources lost, and reduced inequality in groups. Moreover, we show that voluntary institutions involving proportional monetary transfers have the capacity to increase the likelihood of the collective solution being implemented to the same extent as fully removing strategic uncertainty (as in *Single P-B*). This result contributes to the growing cumulative evidence on the efficiency gains of increased cooperation through proportional arrangements to distribute donations among public good providers (Blanco et al., 2021; Struwe et al., 2024). This calls for field tests of transfer programs (such as PES) using proportional inclusive payments to foster collective solutions to collective risk social dilemmas.

Our results contribute to enhancing our understanding of the foundations of human cooperation. Comparing groups that only consist of one provider and one beneficiary with larger groups allows us to clearly disentangle the role of selfish reasons, as opposed to uncertainty about the cooperative behavior of others, in explaining self-reliance by providers. In the absence of transfers, in almost half of the cases (48%) single providers are willing to forgo a significant share of their earnings to reach the collective solution, while in the groups with three providers and three beneficiaries the collective solution was implemented only in 10.7% of instances. This illustrates the magnitude of the hindrance strategic uncertainty represents for cooperation. Thus, while self-interest of providers limits the likelihood of collective solutions (in half of the cases in Single P-B the collective solution was not provided), strategic uncertainty is also a highly relevant behavioral factor behind the overwhelming self-reliance that we observe in group-to-group interactions, and that was previously observed in the literature considering groups where all participants can provide collective and private solutions (Gross & De Dreu, 2019). The fact that results in the Control treatment are close to the Nash Equilibrium predicted by the model with fully self-regarding preferences (see section B in the Supplementary Material) seems to indicate that existing other-regarding preferences are almost entirely offset by the presence of strategic uncertainty. In other words, sufficiently high uncertainty regarding the prosocial behavior of others has the potential to almost entirely crowd-out individual's cooperative behavior, leading to significant failures to solve shared challenges collectively. These results highlight the importance for understanding underlying behavioral factors and motivations in collective action dilemmas in order to design better institutions that promote the cooperation against shared problems. It is worth noting that while reducing the group size to a single provider and a single beneficiary minimizes within-role strategic uncertainty, it may introduce other influences, such as individual risk aversion or the value placed on personal recognition and social image concerns. These factors may similarly affect behavior in ways not directly addressed by our current data, warranting further investigation in future studies.

Our approach further acknowledges real-world complexities by considering heterogeneity in the capacity of individuals to protect themselves and others from group damages. This investigation is critical as the existence of beneficiaries can accentuate social dilemmas (Delaney & Jacobson, 2014; Engel & Rockenbach, 2011) leading to less cooperative outcomes without appropriate interventions. In our setting, beneficiaries are fully dependent on providers to protect them from the collective risk, as neither collective nor private solutions are available to them. This best resembles situations where for some individuals private protection is either not available (institutionally, technologically or geographically) or affordable. Gross et al., 2020 show how wealth asymmetries, and the consequent asymmetries in reliance on others, are conducive to a decline in cooperative outcomes, in particular when the cost of the private solution is high. Groups with wealth disparities attempt to cooperate more (i.e., rely less on the private solution), but manage to achieve the collective solution less often. This highlights the added complexity of cooperation in settings where the private solution is not available to everyone. Our results complement these findings in that they introduce institutional arrangements that mitigate this additional layer of complexity. This in turn fosters the emergence of cooperative outcomes that individuals may aspire to achieve but cannot reach due to strategic uncertainty.

Future research could address further complexities in the provider-beneficiary collective risk social dilemma. For example, in many field settings the number of beneficiaries strongly exceeds that of providers. That is, often many people are relying on the prosocial behavior of few others, which results in relevant power-asymmetries between providers and beneficiaries not considered here. Further, the use of individual solutions can potentially have externalities on others that is abstracted away from in our study. For example, storm-proofing one's house against a hurricane reduces the chance that it damages other houses; while individual crime prevention from setting up private security cameras can have negative externalities on others who do not or cannot afford to have such systems.

The institutions considered here to generate reductions in strategic uncertainty are based on voluntary behavior, and thus present advantages in terms of policy acceptability as compared to other alternative policies (e.g. mandates or taxes). The fact that beneficiaries in our study, on average, voluntarily transferred at least their fair-share of the cost for collective protection emphasizes their willingness to contribute to the collective solution. This complements previous findings in Gross and Böhm, 2020 showing that a majority of individuals vote for restrictive institutions that ban individual solutions to shared problems. While this may be difficult to implement for policy-makers in most contexts, it can nevertheless be interpreted as a strong preference for reducing strategic uncertainty towards achieving welfare-efficient cooperative solutions. These two observations jointly support the acceptability of policies that limit uncertainty about the behavior of others, and that under reduced uncertainty people are willing to foster their cooperation with others; both being essential to efficiently deal with the interrelated global crises we are facing.

4. Methods

Data collection. The experiment was programmed in oTree (D. L. Chen et al., 2016) and the data was collected at the EconLab of the University of Innsbruck, Austria, between May and November 2023. We conducted a total of 20 experimental sessions consisting of 12 to 24 participants per session, for a total sample size of 400 participants.¹ Treatments were assigned at the session level. Each treatment was assigned to 20 groups in total, that is to 40 participants in the *Single P-B* treatment and 120 participants in each of the other treatments. Participants were recruited using the hroot platform (Bock et al., 2014) from the student pool of the university. All participants only took part in one treatment condition in a between-subjects design. See Table S1 in section C.1 of the Supplementary Materials for an overview of participant characteristics in each treatment. Sessions lasted for about one hour and participants earned on average 15.18€, which includes a base payment of 6€.

¹ This sample size was determined in order to detect differences in providers' individual contributions to the public pool of 0.18 SD between any two treatments among *Control, Proportional* or *Pledges* at conventional significance ($\alpha = 0.05$) and power levels ($\beta = 0.8$), with calculations based on data from previous provider-beneficiary experiments (Blanco et al., 2021). For beneficiaries, the sample size enables to detect differences in contributions to the transfer pool of about 0.21 SD between *Proportional* and *Pledges*, depending on the correlation of repeated measures. We are able to detect differences of around 0.28 SD in group level outcomes – such as establishing the collective solution or average contributions to the public pool / transfer pool – between the *Control* group and each of the treatment conditions.

Experimental Design. An experimental group consists of two subgroups, specifically n_I providers and n_J beneficiaries. Each provider $i \in \{1, ..., n_I\}$ privately decides how much of an initial endowment w to invest in a private pool, $g_{Ii} \in [0, w]$, and how much to invest in a public pool, $g_{Pi} \in [0, w]$, with $g_{Ii} + g_{Pi} \leq w$. If g_{Ii} reaches the pre-defined private threshold c_i then provider i keeps the share of w not invested in either pool (reaching the individual solution). If the sum of providers' investments in the public pool, $G_P = \sum_{i}^{n_I} g_{Pi}$ reaches the pre-defined public threshold c_p , then all group members, providers and beneficiaries, are protected from the loss of their resources and each provider keeps the share of w not invested (the collective solution). Crucially, the private threshold is strictly lower than the average amount each provider would have to contribute in order to reach the public threshold, that is $c_i < \frac{1}{n_i}c_p$. As a consequence, it is cheaper for a provider to privately protect themselves rather than sharing the cost of reaching the public threshold equally with other providers. Beneficiaries on the other hand, cannot invest into either the private or the public pool. They fully rely on providers sufficiently investing into the public pool to be protected from the loss of their entire endowment w. The public pool thus resembles a threshold public good, since investments, if sufficient, benefit all members of the group equally. If a provider's investments do not reach any of the two thresholds, their whole endowment wis lost.

This strategic situation is characterized by a social dilemma, since social welfare is maximized if investments into the public pool reach the public threshold and thus protect both providers and beneficiaries from losing their remaining resources. In addition, free-riding threats and high strategic uncertainty provide incentives for providers to only protect themselves by investing in the private pool (which is perfectly excludable, and hence safe from free-riding of other providers and from the risk that efforts to collectively solve the problem fail).

Treatments. In the *control* condition, $n_I = 3$ providers and $n_J = 3$ beneficiaries form a group of a total of N = 6 members. Each provider and each beneficiary is endowed with w = 100 points in their private account. The private threshold for the private pool is defined at $c_i = 30$ points and the threshold for the public pool is $c_p = 120$ points. As such, the crucial condition that $c_i < \frac{c_p}{3} = 40$ is respected. Beneficiaries remain fully passive in this treatment, relying on providers to reach the public threshold in order not to lose their endowment. The payoff functions of providers and beneficiaries for a given round in the *Control* treatment are formalized in equations (1) and (2), respectively:

$$\pi_{i} = \begin{cases} w - g_{Ii} - g_{Pi}, & \text{if either } c_{i} \text{ or } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(1)
$$\pi_{j} = \begin{cases} w, & \text{if } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(2)

The *Proportional* treatment introduces the possibility of transfers from beneficiaries to providers, and thus turns the decision setting into a two-stage game. As in the *control* treatment, the total group size is N = 6, with $n_I = 3$ providers and $n_J = 3$ beneficiaries, and all are endowed with w = 100points in their private account. In stage 1 each beneficiary $j \in \{1, \ldots, n_J\}$ privately decides how much of their endowment w to invest in the so-called 'transfer pool', $t_j \in [0, w]$. The size of the transfer pool is given by the sum of the individual transfers of beneficiaries: $T = \sum_{j=1}^{n_J} t_j$. At the beginning of stage 2, the size of the transfer pool is communicated to providers who then make their investment decision. The private threshold is again defined at $c_i = 30$ points and the public threshold is $c_p = 120$ points. The transfer pool T is proportionally shared among providers based on their contribution to the public pool, g_{Pi} , relative to the sum of contributions of all providers, $G_P = \sum_{i}^{n_I} g_{Pi}$. That is, each provider receives a share of transfers equal to $(\frac{g_{Pi}}{G_P})T$, if and only if they are protected from losses (by sufficient investments in either the private or the public pool). Otherwise, the provider loses their share of transfers together with all other remaining resources from the initial endowment. Note that the share of transfers of any provider who is not protected by either the private or the collective solution is lost, and is therefore not redistributed among the other providers nor returned to beneficiaries. The payoff functions of providers and beneficiaries in the *proportional* treatment are formally given in equations (3) and (4), respectively:

$$\pi_{i} = \begin{cases} w - g_{Ii} - g_{Pi} + \left(\frac{g_{Pi}}{G_{P}}\right)T, & \text{if either } c_{i} \text{ or } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(3)

$$\pi_j = \begin{cases} w - t_j, & \text{if } c_p \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(4)

In previous studies, Blanco et al., 2021 and Struwe et al., 2022 have investigate whether different ways of allocating beneficiary transfers to providers affect cooperation levels among the latter. While Struwe et al., 2022 finds that the proportional allocation leads to significantly higher cooperation with respect to the baseline of absent transfers, the results in Blanco et al., 2021 also suggest that proportional sharing rules lead to a greater public good provision compared to an fair share whereby all providers receive the same proportion of transfers, independently of their effort. As such, we chose to test the proportional transfer allocation mechanism with decreasing levels of strategic uncertainty.

The *Pledges* treatment turns the decision-setting into a three stage game, where in stage 1 both providers and beneficiaries are asked to make a non-binding numerical "promise" of how much they intend to contribute to the public and transfer pools, respectively. These pledges are then revealed to the other providers or beneficiaries before they can make a decision. Importantly, providers do not observe beneficiaries' pledges and vice-versa. Stages 2 and 3 are then identical to the decision setting in the *Proportional* treatment. As argued by Bochet and Putterman, 2009, pledges help alleviate strategic uncertainty. Indeed, experimental evidence has repeatedly shown behavioural changes in response to non-binding communication, leading to higher levels of cooperation in social dilemma situations (see, for example, Bochet et al., 2006; Bochet & Putterman, 2009; Isaac & Walker, 1988; Koessler, 2022; Koukoumelis et al., 2012; Oprea et al., 2014; Ostrom et al., 1994; Palfrey & Rosenthal, 1991; Pogrebna et al., 2011; Sally, 1995; Tavoni et al., 2011). Previous evidence shows non-binding numerical pledges to be effective in raising efficiency in settings where it is paired with review and sanctioning mechanisms (Barrett & Dannenberg, 2016; Bochet & Putterman, 2009; Denant-Boemont et al., 2011; Kroll et al., 2007), or in a continuous choices between private and collective solutions against collective losses (McEvoy et al., 2022).

The *Single P-B* treatment treatment reduces the number of group members to one provider and one beneficiary. By doing so, we remove the strategic uncertainty linked to the behavior of other group members of the same type: the single provider knows exactly the necessary investment in the public pool in order to reach the public threshold c_p , and the single beneficiary knows precisely the amount that will be transferred to the provider. As in the other treatments, both group members are endowed

with w = 100 and the private threshold is $c_i = 30$. For comparability, due to the smaller group size, the public threshold is reduced to $c_p = 40$, holding constant the relative share of the group endowment necessary to reach the public threshold. Importantly, the single provider receives the entirety of the transfers offered by the single beneficiary, $T = t_j$, independently of the contribution to the public pool (provided the provider is protected through either the private or the collective solution). The payoff functions for the provider and beneficiary in this treatment condition are given in equations (7) and (8):

$$\pi_{i} = \begin{cases} w - g_{Ii} - g_{Pi} + t_{j}, & \text{if either } c_{i} \text{ or } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(5)
$$\pi_{j} = \begin{cases} w - t_{j}, & \text{if } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(6)

Procedures. An experimental session consists of a total of 15 decision rounds divided into two parts: 5 baseline rounds in Part 1 with passive beneficiaries and 10 treatment rounds in Part 2. Participants learned the details of Part 2 only after completion of Part 1. All instructions were available for participants on the computer screen and participants had to go through a series of control questions after each set of instructions to test their understanding of the game (all materials are available in section E of the Supplementary Materials). Participants were randomly assigned to groups and the role of either provider (referred to as Type A players in the experiment) or beneficiary (referred to as Type B players in the experiment). Both groups and player roles remained fixed for the duration of the experiment.

Part 1 was identical for all treatments and corresponds to the decision-setting in *Control* with passive beneficiaries. The only difference between treatments in these five baseline rounds was the smaller group size in Single P-B compared to Control, Proportional and Pledges. In each round, providers made their investment decisions, while beneficiaries were asked to estimate the average individual contribution to the public pool by the providers in their group. At the end of each round, all participants received information about the aggregate number of points invested in the public pool, whether the public threshold was reached or not, and thus whether the group members were protected from losing their endowment through the collective solution. Additionally, all participants received feedback on the individual contributions to the public pool of each provider in the group and the payoffs of all group members (following Gross and Böhm, 2020; Gross and De Dreu, 2019; Gross et al., 2020). Each provider also received private information on their contribution to the private pool and whether they reached their individual threshold - and were thus protected through the individual solution - or not. To avoid reputation building over time, information was only available for the current period and provided in random order with anonymised subject IDs (following the common approach in the literature, see for example Fehr and Gächter, 2000; Gross and Böhm, 2020; Gross and De Dreu, 2019; Gross et al., 2020; Sefton et al., 2007). As in previous provider-beneficiary experiments, including baseline rounds in the experimental design provides a history where providers have made decisions with externalities to a broader population, but have not been compensated for these public good provision efforts, as is the case in most field settings. Further, Part 1 also provides statistical control when examining variation in behavior across groups due to treatment effects.

In the ten rounds of *Part 2* the decision setting depends on the specific treatment condition described above. In the three treatments with transfers, in each round, providers were initially asked to give an estimate about expected average transfers from beneficiaries, and beneficiaries were asked to give an estimate about expected average public pool contributions of providers. In *Control*, beneficiaries made an estimate about the expected behavior of providers as in Part 1. At the end of each round in Part 2, in addition to the feedback information provided in Part 1, all participants received anonymized information on the individual transfers of beneficiaries to the transfer pool. In *Proportional* and *Pledges*, each provider was privately informed about their share of transfers received. If the sum of contributions to the public pool was zero, then all providers received an fair share of the transfer pool.

At the end of the experiment, after parts 1 and 2, each participant was asked to answer a questionnaire with questions on socio-economic background, real-life donation behavior and volunteering behavior, as well as motivations during the decision making part of the experiment.

References

- Andreoni, J. (1990). Impure altruism and donations to public goods: A theory of warm-glow giving. *The economic journal*, *100*(401), 464–477.
- Andreoni, J. (1998). Toward a theory of charitable fund-raising. *Journal of Political Economy*, 106(6), 1186–1213.
- Ariely, D., Bracha, A., & Meier, S. (2009). Doing good or doing well? image motivation and monetary incentives in behaving prosocially. *American economic review*, *99*(1), 544–555.
- Barrett, S., & Dannenberg, A. (2012). Climate negotiations under scientific uncertainty. *Proceedings of the National Academy of Sciences*, *109*(43), 17372–17376.
- Barrett, S., & Dannenberg, A. (2014). Sensitivity of collective action to uncertainty about climate tipping points. *Nature Climate Change*, *4*(1), 36–39.
- Barrett, S., & Dannenberg, A. (2016). An experimental investigation into 'pledge and review'in climate negotiations. *Climatic Change, 138*, 339–351.
- Barrett, S., & Dannenberg, A. (2022). The decision to link trade agreements to the supply of global public goods. *Journal of the Association of Environmental and Resource Economists*, *9*(2), 273–305.
- Bekkers, R., & Wiepking, P. (2011). A literature review of empirical studies of philanthropy: Eight mechanisms that drive charitable giving. *Nonprofit and voluntary sector quarterly*, *40*(5), 924–973.
- Bénabou, R., & Tirole, J. (2006). Incentives and prosocial behavior. *American economic review*, 96(5), 1652–1678.
- Blanco, E., Dutcher, E. G., & Haller, T. (2020). Social dilemmas with public and private insurance against losses. *Journal of Economic Behavior & Organization*, *180*, 924–937.
- Blanco, E., Haller, T., & Walker, J. M. (2017). Externalities in appropriation: Responses to probabilistic losses. *Experimental Economics*, *20*, 793–808.
- Blanco, E., Haller, T., & Walker, J. M. (2018). Provision of environmental public goods: Unconditional and conditional donations from outsiders. *Journal of Environmental Economics and Management*, 92, 815–831.
- Blanco, E., Lopez, M. C., & Walker, J. M. (2016). The opportunity costs of conservation with deterministic and probabilistic degradation externalities. *Environmental and Resource Economics*, *64*, 255–273.
- Blanco, E., Struwe, N., & Walker, J. M. (2021). Experimental evidence on sharing rules and additionality in transfer payments. *Journal of Economic Behavior & Organization*, *188*, 1221–1247.
- Bochet, O., Page, T., & Putterman, L. (2006). Communication and punishment in voluntary contribution experiments. *Journal of Economic Behavior & Organization*, 60(1), 11–26.
- Bochet, O., & Putterman, L. (2009). Not just babble: Opening the black box of communication in a voluntary contribution experiment. *European Economic Review*, *53*(3), 309–326.
- Bock, O., Baetge, I., & Nicklisch, A. (2014). Hroot: Hamburg registration and organization online tool. *European Economic Review*, *71*, 117–120.
- Bracha, A., Menietti, M., & Vesterlund, L. (2011). Seeds to succeed?: Sequential giving to public projects. *Journal of Public Economics*, *95*(5-6), 416–427.
- Burton-Chellew, M. N., May, R. M., & West, S. A. (2013). Combined inequality in wealth and risk leads to disaster in the climate change game. *Climatic change*, *120*, 815–830.

- Butz, B., & Harbring, C. (2020). Donations as an incentive for cooperation in public good games. *Journal* of Behavioral and Experimental Economics, 85, 101510.
- Chen, D. L., Schonger, M., & Wickens, C. (2016). Otree—an open-source platform for laboratory, online, and field experiments. *Journal of Behavioral and Experimental Finance*, *9*, 88–97.
- Chen, X.-P., & Komorita, S. S. (1994). The effects of communication and commitment in a public goods social dilemma. *Organizational Behavior and Human Decision Processes*, *60*(3), 367–386.
- Chichilnisky, G., & Heal, G. (1998). Economic returns from the biosphere. Nature, 391(6668), 629-630.
- Delaney, J., & Jacobson, S. (2014). Those outsiders: How downstream externalities affect public good provision. *Journal of Environmental Economics and Management*, 67(3), 340–352.
- DellaVigna, S., List, J. A., & Malmendier, U. (2012). Testing for altruism and social pressure in charitable giving. *The quarterly journal of economics*, *127*(1), 1–56.
- Denant-Boemont, L., Masclet, D., & Noussair, C. (2011). Announcement, observation and honesty in the voluntary contributions game. *Pacific Economic Review*, *16*(2), 207–228.
- Engel, C., & Rockenbach, B. (2011). We are not alone: The impact of externalities on public good provision. *MPI Collective Goods Preprint*, (2009/29).
- Epperson, R., & Reif, C. (2019). Matching subsidies and voluntary contributions: A review. *Journal of Economic Surveys*, *33*(5), 1578–1601.
- Erdlenbruch, K., Thoyer, S., Grelot, F., Kast, R., & Enjolras, G. (2009). Risk-sharing policies in the context of the french flood prevention action programmes. *Journal of environmental management*, *91*(2), 363–369.
- Fehr, E., & Gächter, S. (2000). Cooperation and punishment in public goods experiments. American Economic Review, 90(4), 980–994. https://doi.org/10.1257/aer.90.4.980
- Ferraro, P. J. (2011). The future of payments for environmental services. *Conservation biology*, 25(6), 1134–1138.
- Ferraro, P. J., & Kiss, A. (2002). Direct payments to conserve biodiversity.
- Frey, B. S., & Meier, S. (2004). Social comparisons and pro-social behavior: Testing "conditional cooperation" in a field experiment. *American economic review*, *94*(5), 1717–1722.
- Gangadharan, L., & Nemes, V. (2009). Experimental analysis of risk and uncertainty in provisioning private and public goods. *Economic Inquiry*, 47(1), 146–164.
- Garcia, T., Massoni, S., & Villeval, M. C. (2020). Ambiguity and excuse-driven behavior in charitable giving. *European Economic Review*, 124, 103412.
- Gneezy, U., Keenan, E. A., & Gneezy, A. (2014). Avoiding overhead aversion in charity. *Science*, *346*(6209), 632–635.
- Grant, L., & Langpap, C. (2019). Private provision of public goods by environmental groups. *Proceedings* of the National Academy of Sciences, 116(12), 5334–5340.
- Gross, J., & Böhm, R. (2020). Voluntary restrictions on self-reliance increase cooperation and mitigate wealth inequality. *Proceedings of the National Academy of Sciences*, *117*(46), 29202–29211.
- Gross, J., & De Dreu, C. K. (2019). Individual solutions to shared problems create a modern tragedy of the commons. *Science advances*, *5*(4).

- Gross, J., Veistola, S., De Dreu, C. K., & Van Dijk, E. (2020). Self-reliance crowds out group cooperation and increases wealth inequality. *Nature Communications*, *11*(1), 5161.
- Huck, S., & Rasul, I. (2011). Matched fundraising: Evidence from a natural field experiment. *Journal of Public Economics*, *95*(5-6), 351–362.
- IPCC. (2023). Climate change 2023: Synthesis report. contribution of working groups i, ii and iii to the sixth assessment report of the intergovernmental panel on climate change [core writing team, h. lee and j. romero (eds.)]
- Isaac, R. M., & Walker, J. M. (1988). Communication and free-riding behavior: The voluntary contribution mechanism. *Economic inquiry*, *26*(4), 585–608.
- Jagers, S. C., Harring, N., Löfgren, Å., Sjöstedt, M., Alpizar, F., Brülde, B., Langlet, D., Nilsson, A., Almroth, B. C., Dupont, S., et al. (2020). On the preconditions for large-scale collective action. *Ambio*, 49, 1282–1296.
- Karlan, D., & List, J. A. (2007). Does price matter in charitable giving? evidence from a large-scale natural field experiment. *American Economic Review*, 97(5), 1774–1793.
- Kinzig, A. P., Perrings, C., Chapin Iii, F., Polasky, S., Smith, V. K., Tilman, D., & Turner, B. (2011). Paying for ecosystem services—promise and peril. *Science*, 334(6056), 603–604.
- Koessler, A.-K. (2022). Pledges and how social influence shapes their effectiveness. *Journal of Behavioral and Experimental Economics*, *98*, 101848.
- Koukoumelis, A., Levati, M. V., & Weisser, J. (2012). Leading by words: A voluntary contribution experiment with one-way communication. *Journal of Economic Behavior & Organization*, 81(2), 379– 390.
- Kroll, S., Cherry, T. L., & Shogren, J. F. (2007). Voting, punishment, and public goods. *Economic Inquiry*, 45(3), 557–570.
- Lenton, T. M. (2013). Environmental tipping points. *Annual Review of Environment and Resources*, 38, 1–29.
- Lippert, S., & Tremewan, J. (2021). Pledge-and-review in the laboratory. *Games and Economic Behavior*, 130, 179–195.
- List, J. A. (2011). The market for charitable giving. Journal of Economic Perspectives, 25(2), 157–180.
- McEvoy, D. M., Haller, T., & Blanco, E. (2022). The role of non-binding pledges in social dilemmas with mitigation and adaptation. *Environmental and Resource Economics*, *81*(4), 685–710.
- Milinski, M., & Marotzke, J. (2022). Economic experiments support ostrom's polycentric approach to mitigating climate change. *Humanities and Social Sciences Communications*, 9(1), 1–9.
- Milinski, M., Röhl, T., & Marotzke, J. (2011). Cooperative interaction of rich and poor can be catalyzed by intermediate climate targets: A letter. *Climatic change*, *109*, 807–814.
- Milinski, M., Semmann, D., Krambeck, H.-J., & Marotzke, J. (2006). Stabilizing the earth's climate is not a losing game: Supporting evidence from public goods experiments. *Proceedings of the National Academy of Sciences*, *103*(11), 3994–3998.
- Milinski, M., Sommerfeld, R. D., Krambeck, H.-J., Reed, F. A., & Marotzke, J. (2008). The collective-risk social dilemma and the prevention of simulated dangerous climate change. *Proceedings of the National Academy of Sciences*, *105*(7), 2291–2294.

- Oprea, R., Charness, G., & Friedman, D. (2014). Continuous time and communication in a public-goods experiment. *Journal of Economic Behavior & Organization*, *108*, 212–223.
- Ostrom, E., Gardner, R., & Walker, J. (1994). Rules, games, and common-pool resources. University of Michigan press.
- Palfrey, T., & Rosenthal, H. (1991). Testing for effects of cheap talk in a public goods game with private information. *Games and economic behavior*, *3*(2), 183–220.
- Palfrey, T., Rosenthal, H., & Roy, N. (2017). How cheap talk enhances efficiency in threshold public goods games. *Games and Economic Behavior*, *101*, 234–259.
- Pogrebna, G., Krantz, D. H., Schade, C., & Keser, C. (2011). Words versus actions as a means to influence cooperation in social dilemma situations. *Theory and Decision*, *71*, 473–502.
- Sally, D. (1995). Conversation and cooperation in social dilemmas: A meta-analysis of experiments from 1958 to 1992. *Rationality and society*, *7*(1), 58–92.
- Salzman, J., Bennett, G., Carroll, N., Goldstein, A., & Jenkins, M. (2018). The global status and trends of payments for ecosystem services. *Nature Sustainability*, *1*(3), 136–144.
- Sefton, M., Shupp, R., & Walker, J. M. (2007). The effect of rewards and sanctions in provision of public goods. *Economic inquiry*, 45(4), 671–690.
- Shang, J., & Croson, R. (2009). A field experiment in charitable contribution: The impact of social information on the voluntary provision of public goods. *The economic journal*, *119*(540), 1422–1439.
- Struwe, N., Blanco, E., & Walker, J. M. (2022). Competition among public good providers for donor rewards. *Experimental Economics*, 1–29.
- Struwe, N., Blanco, E., & Walker, J. M. (2024). Competition among public good providers for donor rewards. *Experimental Economics*, 27(1), 215–243.
- Struwe, N., Bogner, K., & Blanco, E. (2023). Why do ousiders make donations to public good providers? *Behavioral Economics and the Environment, Routledge.*
- Tavoni, A., Dannenberg, A., Kallis, G., & Löschel, A. (2011). Inequality, communication, and the avoidance of disastrous climate change in a public goods game. *Proceedings of the National Academy of Sciences*, *108*(29), 11825–11829.
- Tompkins, E. L., & Eakin, H. (2012). Managing private and public adaptation to climate change. Global Environmental Change, 22(1), 3–11. Retrieved February 15, 2022, from https://www. sciencedirect.com/science/article/pii/S0959378011001452
- Vasconcelos, V. V., Santos, F. C., Pacheco, J. M., & Levin, S. A. (2014). Climate policies under wealth inequality. Proceedings of the National Academy of Sciences, 111(6), 2212–2216.
- Vesterlund, L. (2003). The informational value of sequential fundraising. *Journal of public Economics*, 87(3-4), 627–657.
- Wilson, R. K., & Sell, J. (1997). "liar, liar..." cheap talk and reputation in repeated public goods settings. *Journal of Conflict Resolution*, 41(5), 695–717.

Supplementary Material

Reducing strategic uncertainty increases group protection in collective risk social dilemmas

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A. Related Literature

As touched upon in the introductory section of the manuscript, our experimental design studies collective risk social dilemmas building on the decision environments introduced by Gross and De Dreu, 2019 and Blanco et al., 2018. The latter studies the impact of resource transfers on cooperation between public good providers and beneficiaries of the public good that cannot contribute to its provision, not unlike in our setting. They find that such transfers, both conditional on the provision of the public good and unconditional, do not significantly foster lasting cooperation. The former, on the other hand, investigate how individuals decide between private and collective forms of insurance against losses modeled as a threshold public good, similar to our experimental design. They find that individuals favor selfreliance when the cost of the collective solution is similar to that of the private one, and only retort to cooperation when the cost of self-reliance is relatively high.

Two additional studies extend the framework of Gross and De Dreu, 2019. Gross and Böhm, 2020 allow participant groups to periodically vote on restricting access to the private solution, thereby forcing themselves to solve the problem cooperatively. They find that, given the opportunity to do so, groups overwhelmingly opted for such a restriction, in particular in treatments with a medium to high degree of interdependence (i.e., high relative cost of the private solution). The consequence was a marked decrease in resources wasted, inequality, and an increase in earnings. The choice to self restrict of a significant majority of individuals can be interpreted as a strong preference for reducing strategic uncertainty towards achieving welfare-efficient cooperative solutions. Finally, Gross et al., 2020 consider the effect of varying relative solution costs in the presence of asymmetries in individuals' initial endowment. In the extreme case, this entails some individuals fully relying on the collective solution to be protected from the loss of their resources as the cost of private insurance is too high. This is the treatment that most resembles our experimental design since in our case, too, beneficiaries are fully dependent on the collective action of providers. The main difference lies in the fact that in Gross et al., 2020 all group members can contribute to the public solution, while in our case beneficiaries can only contribute to the public solution indirectly, by transferring part of their endowment to providers.

Furthermore, our study contributes to two further important strands of the literature. Firstly, we contribute to the large literature on the behavioral determinants of charitable giving (e.g. Andreoni, 1990; Ariely et al., 2009; Bénabou & Tirole, 2006; Frey & Meier, 2004; Garcia et al., 2020; Gneezy et al., 2014; Vesterlund, 2003) by considering for the first time the role of donors in a collective risk social dilemma. Designing successful fundraising activities builds on knowledge of the motivations of why people donate, such as warm-glow, altruism, or awareness of need (see, for example, Butz and Harbring, 2020; List, 2011; and for an overview see Bekkers and Wiepking, 2011). Our research complements previous studies that have considered exogenously provided incentives to raise donations such as matching donations (see Huck and Rasul, 2011 and Karlan and List, 2007; as well as Epperson and Reif, 2019 for a review), social comparisons (DellaVigna et al., 2012; Shang & Croson, 2009), or seed money announcements (Andreoni, 1998; Bracha et al., 2011). All mentioned studies have in common that they focus only on the side of donations and do not consider the actual output of the public good the money was raised for. Blanco et al., 2018; Blanco et al., 2021 and Struwe et al., 2022 investigate the impact of endogenous donations on the investments by public good providers in contributing to public goods benefiting providers and donors.² Considering beneficiaries' motives for donations to public good providers, Struwe et al., 2023

² Another exception is the study by Grant and Langpap, 2019 who find that donations to watershed groups, a common form of environmental organization in the US, were related to higher expenditures by these groups, which lead to measurable improvements in water quality.

suggests that donors driven by cooperative concerns offer significantly higher donations under a proportional sharing rule than under unconditional sharing of donations. This finding highlights donors' receptiveness to changes in the strategic uncertainty of the decision setting that we explore to a larger extent in this study.

Lastly, we contribute to the literature studying the effectiveness of non-binding pledges on cooperation in public good settings. Standard economic theory considering self-interested profit-maximizing individuals would predict that so-called "cheap talk" in the form of non-binding pledges should bear no influence on individual decision making and thus cooperation levels. However, as argued by Bochet and Putterman, 2009, pledges help alleviate strategic uncertainty. Indeed, experimental evidence has repeatedly shown behavioural changes in response to non-binding communication, leading to higher levels of cooperation in social dilemma situations (see, for example, Bochet et al., 2006; Bochet & Putterman, 2009; Isaac & Walker, 1988; Koessler, 2022; Koukoumelis et al., 2012; Oprea et al., 2014; Ostrom et al., 1994; Palfrey & Rosenthal, 1991; Pogrebna et al., 2011; Sally, 1995; Tavoni et al., 2011). However, results for numerical pledges are more modest. Results from linear and threshold public good games show that just announcing one's intended numeric contribution does not systematically increase cooperation (Bochet et al., 2006; X.-P. Chen & Komorita, 1994; Palfrey et al., 2017; Wilson & Sell, 1997). In particular, Palfrey et al., 2017 provide evidence that cheap talk leads to higher contributions to a threshold public good only in the case of unrestricted communication in natural language, while the mere announcement of a numeric pledge is ineffective. Nevertheless, previous evidence shows non-binding numerical pledges to be effective in raising efficiency in settings where it is paired with review and sanctioning mechanisms (Barrett & Dannenberg, 2016; Bochet & Putterman, 2009; Denant-Boemont et al., 2011; Kroll et al., 2007), or in a continuous choices between private and collective solutions against collective losses (McEvoy et al., 2022). In this study, we investigate for the first time the effectiveness of pledges to serve as a coordination device to further reduce strategic uncertainty in settings with donors and providers of threshold public goods, interacting in a collective risk social dilemma.

B. Theoretical Background

In the following, the formal derivation of optimal behavior in each treatment condition only takes into account monetary payoff incentives, thus relying on the assumption of fully self-regarded payoff maximizing individuals. We start with the presentation of the general model with active beneficiaries and proportional distribution of transfers. The different special cases (passive beneficiaries and single provider-single beneficiary) are illustrated successively. Finally, given that the model only includes self-regarding preferences, there are no formal differences between the *Proportional* and the *Pledges* treatments. For convenience, only the former is presented here.

B.1. General model with active beneficiaries and proportional distribution of transfers

 n_I providers and n_J beneficiaries form a group of $N = n_I + n_J$ subjects. Each subject is endowed with w points. Each provider i must choose how many points to allocate to her own private pool, g_{Ii} , how many to allocate to the public pool, g_{Pi} , and how many to keep for herself. Similarly, each beneficiary j has to choose how many points to allocate to the transfer pool, t_j , and how many to keep for himself. If the points allocated to provider i's private pool reach the pre-defined private threshold c_i , then she is protected against the loss of the points she did not invest in either of the pools, that is $w - g_{Ii} - g_{Pi}$. If the sum of providers' contributions to the public pool, $G_P = \sum_{i=1}^{n_I} g_{Pi}$, reaches the pre-defined public threshold c_p , then all subjects, both providers and beneficiaries, can keep all points they have not invested. Crucially, we set $c_i < \frac{c_p}{n_I}$ to ensure the existence of a social dilemma. Finally, if provider i is protected against the loss of her resources because either c_i or c_p (or both) are reached, then she is allocated a share of the transfer account $T = \sum_{j=1}^{n_J} t_j$ proportional to her own share of contributions to the public pool, that is $\frac{g_{Pi}}{G_P}$.

We will assume throughout that all subjects have identical self-regarding preferences and are perfectly informed. The payoff functions of providers and beneficiaries are thus given in equations (1) and (2):

$$\pi_{i} = \begin{cases} w - g_{Ii} - g_{Pi} + \left(\frac{g_{Pi}}{G_{P}}\right)T, & \text{if either } c_{i} \text{ or } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(1)

$$\pi_j = \begin{cases} w - t_j, & \text{if } c_p \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(2)

We can rewrite the maximisation problem facing provider *i* distinguishing her own contribution to G_P , g_{Pi} , from that of all other providers, $g_{P-i} = \sum_{\substack{k=1\\k\neq i}}^{n_I} g_{Pk}$, as follows:

$$\max_{g_{P_i}} \pi_i = w - g_{Ii} - g_{Pi} + \left(\frac{g_{Pi}}{g_{Pi} + g_{P-i}}\right)T,\tag{3}$$

The first order condition of provider *i*'s maximisation problem is given by:

$$\frac{\partial \pi_i}{\partial g_{Pi}} = \frac{g_{P-i}T}{(g_{Pi} + g_{P-i})^2} - 1 = 0 \tag{4}$$

From which we obtain provider *i*'s best response function to the contribution level of all other providers to the public pool, g_{P-i} :

$$g_{Pi} = \max(0, -g_{P-i} + \sqrt{g_{P-i}T})$$
(5)

From equation (5) we can make the following considerations:

- a) If $T = 0 \Rightarrow g_{Pi} = 0$. In the absence of transfers, providers have no monetary incentives to invest in the public pool, and will privately protect themselves individually by investing c_i in their private pool.
- b) If $T > g_{P-i} \Rightarrow g_{Pi} > 0$. As long as $g_{P-i} > 0$, provider *i* has a positive monetary incentive to invest in the public pool in order to obtain a proportional share of the transfers. This incentive remains even if the threshold c_p is not reached.
- c) Furthermore, if T > g_{P-i} ⇒ g_{Pi} < T g_{P-i}. provider i's individual contribution to the public pool, g_{Pi}, will never be sufficiently large to cover the difference between aggregate transfers T and other providers' contributions g_{P-i}. As a consequence, due to the functional form of function (5) it will always hold that G_P < T.
- d) Finally, if 0 < T < g_{P-i} ⇒ g_{Pi} = 0. If the contribution of providers other than *i* to the public pool, g_{P-i}, is higher than the aggregate transfers received from beneficiaries, provider *i* has no incentive to contribute to the public pool. This is because the marginal unitary cost of contributing to the public pool becomes higher than the marginal benefit brought by the increase in share of transfers obtained, ¹/_{n_I}T. In this case, provider *i* will privately protect herself by investing c_i in g_{Ii} and contributes g_{Pi} = 0 to the public pool.

For any given level of g_{P-i} , individual contributions g_{Pi} are positively correlated with T. This means that there must exist a threshold value T^* for which $G_P = c_p$ and the collective solution is reached. Furthermore, consideration c) above tells us that the aggregate level of transfers must be strictly greater than the public threshold, hence it must be that $T^* > c_p$.

Identification of the Nash Equilibrium and Social Optimum:

By symmetry of the preferences we have:

$$g_{Pi} = \frac{1}{n_I - 1} g_{P-i} \qquad \Leftrightarrow \qquad g_{P-i} = (n_I - 1) g_{Pi}$$

Substituting into equation (5) gives:

$$g_{Pi} = -(n_I - 1)g_{Pi} + \sqrt{(n_I - 1)g_{Pi}T}$$

The optimal g_{Pi} as a function of transfers is given by equation (6):

$$g_{Pi}^* = \frac{n_I - 1}{n_I^2} * T \ \forall \ i \tag{6}$$

beneficiaries choose t_j such that:

$$\sum_{i=1}^{n_I} g_{Pi}^* = c_p \qquad \Leftrightarrow \qquad g_{Pi}^* = \frac{1}{n_I} c_p \tag{7}$$

The optimal t_j from the beneficiaries' perspective can be derived by equalising equations (6) and (7) and dividing by the number of beneficiaries. It is expressed in equation (9):

$$T^* = \frac{n_I}{n_I - 1} c_p \tag{8}$$

$$t_j^* = \frac{n_I/n_J}{n_I - 1} c_p \forall j \tag{9}$$

Note that in our experiment it is the case that $n_I = n_J$, and the optimal transfer level for beneficiaries is thus reported in the manuscript as:

$$t_j^* = \frac{c_p}{n_I - 1}$$

The optimal g_{Pi} from the providers' perspective is obtained by substituting equation (8) in (6) and solving for g_{Pi} . It is given by equation (10):

$$g_{Pi}^* = \frac{c_p}{n_I} \forall i \tag{10}$$

The Nash Equilibrium is thus $S^* = (g_{Ii}^*, g_{Pi}^*, t_j^*) = (0, \frac{c_p}{n_I}, \frac{n_I/n_J}{n_I - 1}c_p) \forall i, j$. Albeit not being fair in terms of distribution, the Nash Equilibrium is efficient as it entails the minimal aggregate loss c_p , and is thus social welfare maximising. This is demonstrated in the following lines:

The condition for the social optimum is the minimal loss of resources, i.e., that aggregate group payoffs equal the sum of the endowments of all subjects net of the minimal aggregate contribution necessary to reach the collective solution, c_p :

$$\pi_T^* = Nw - c_p$$

To show that the Nash Equilibrium leads to the socially optimal outcome, we can rewrite equation (1) as follows, substituting the derived individual optimal behavior:

$$\pi_i^* = w - g_{Ii}^* - g_{Pi}^* + \frac{g_{Pi}^*}{n_I * g_{Pi}^*} T$$
$$= w - \frac{c_p}{n_I} + \frac{1}{n_I} * T$$

We obtain the aggregate payoff for providers:

$$\pi_I^* = \sum_{i=1}^{n_I} \pi_i^*$$
$$= n_I \pi_i^*$$
$$= n_I w - c_p + T$$

Substituting individual optimal behavior, we can rewrite equation (2) as follows:

$$\pi_j^* = w - t_j$$
$$= w - \frac{n_I/n_J}{n_I - 1}c_p$$

We obtain the aggregate payoff for beneficiaries:

$$\pi_J^* = \sum_{j=1}^{n_J} \pi_j^*$$
$$= n_J \pi_j^*$$
$$= n_J w - \frac{n_I}{n_I - 1} c_p$$
$$= n_J w - T$$

We obtain the total aggregate payoff:

$$\pi_T^* = \pi_I^* + \pi_J^*$$
$$= (n_I + n_J)w - c_p - T + T$$
$$= Nw - c_p$$

This demonstrates that the Nash Equilibrium of this game is indeed social welfare maximising.

In the model presented thus far beneficiaries are active and transfers are shared proportionally among providers. As such, it corresponds to both the *Proportional* and *Pledges* treatments. As a reminder, since

the model does not include preferences other than self-regarding, these two treatments are formally equivalent, and thus presented together in this section.

Figure S1 graphically represents equation (5) and illustrates provider *i*'s optimal contribution to the public pool as a function of the aggregate contribution of other providers for different levels of transfers T. Since her choices are driven purely by the incentive to obtain a large enough share of T, she will contribute to the public solution even if the threshold c_p is not reached, and insure herself privately in parallel. Considerations a) to d), outlined above, can also be observed in Figure S1, as incentives for *i* to contribute positive values of g_{Pi} only exist for values of g_{P-i} between 0 and T. The Nash Equilibrium for the parameters used in our experiment is represented in the figure, for T = 180 and $g_{Pi} = 40$.



Figure S1: Contributions to public pool: reaction function of provider i to other providers for varying lelvels of ${\cal T}$

We next consider two special cases of the model that represent the *Control* and *Single P-B* treatments of our experiment.

B.2. Case 1: T = 0 - Passive beneficiaries

The case with passive beneficiaries corresponds to the baseline game of part 1 of the experiment and to the *Control* treatment. The payoff function of the n_I providers is given in equation (11), while the payoff function of the n_J beneficiaries is given in equation (12):

$$\pi_{i} = \begin{cases} w - g_{Ii} - g_{Pi}, & \text{if either } c_{i} \text{ or } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(11)
$$\pi_{j} = \begin{cases} w, & \text{if } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(12)

The first order conditions for providers are given in equations (13) and (14):

$$\frac{\partial \pi_i}{\partial g_{Ii}} = \begin{cases}
0, & \text{if } g_{Ii} < c_i \\
+\infty & \text{if } g_{Ii} = c_i \\
-1, & \text{if } g_{Ii} > c_i \\
0, & \text{if } G_P < c_p
\end{cases}$$
(13)

$$\frac{\partial \pi_i}{\partial g_{Pi}} = \begin{cases} +\infty & \text{if } G_P = c_p \\ -1, & \text{if } G_P > c_p \end{cases}$$
(14)



Figure S2: provider *i*'s payoff functions in Control treatment

Figure S2 shows a graphic representation of providers' payoff functions. In red, the payoff function of contributing to the private account. Until contributions reach the private threshold c_i payoff remains 0. As soon as the threshold is reached, the payoff "jumps" to $w - c_i$ and then linearly decreases until w is completely invested. The contribution g_{Ii} that maximises providers' payoff would be c_i . Similarly, assuming symmetric preferences for all providers, the payoff function of contribution to the public account, in grey, remains constant at 0 until it reaches the fair share of the public threshold, $\frac{1}{n_I}c_p$, at which point it "jumps" to $w - c_p$ before decreasing towards 0 as g_{Pi} progresses towards w. If we forget for a moment the existence of the private pool, the payoff-maximizing contribution for provider i, g_{Pi} , would be $\frac{1}{n_I}c_p$.

The Nash Equilibrium is given by point A for a total group payoff of $n_I * (w - c_i)$. This can be seen from equation (5), where the absence of transfers would entail a null contribution to the public pool by provider i, $g_{Pi} = 0$. The social optimum on the other hand is given by point B for a total group payoff of $n_I * (w - \frac{1}{n_I}c_p) + n_J * w$, which by definition is strictly larger than the Nash Equilibrium total group payoff (since it entails the minimal aggregate loss c_p), such that point B strictly dominates point A. Figure S3 shows the reaction function of provider i with respect to the contribution of all other providers to the public pool, g_{P-i} . As long as the amount that is left for provider i to contribute to the public pool in order to reach the public threshold after contributions by other providers is larger than the private threshold, that is, as long as $c_p - g_{P-i} > c_i$, provider i will protect herself by investing only in the private pool. Only when this inequality is inverted, will i protect herself by investing $c_p - g_{P-i}$ in the public pool and nothing in the private pool.



Figure S3: provider *i*'s reaction function

Similarly to Figure S2, the Nash Equilibrium is given by point A - where provider i contributes c_i to the private pool only and all providers collectively contribute 0 to the public pool - whereas the social optimum is given by point B - where all providers contribute an equal amount $\frac{1}{n_I}c_p$ to the public pool and nothing to the private pool. Since point B lies outside of individual i's reaction function, it cannot constitute an equilibrium.

B.3. Case 2: $n_I = n_J = 1$ - Single provider and single beneficiary

The second special case of the model, corresponding to the *Single P-B* treatment, entails that $g_{P-i} = 0$ and therefore $G_P = g_{Pi}$, since we consider a single provider only. Similarly, $T = t_j$, since we consider a single beneficiary. This means that the monetary incentive to contribute to the public solution provided by the proportional distribution of transfers is not present in this treatment. In fact, as long as provider *i* is protected against the loss of her resources, she will receive the entirety of transfers *T* independently of her investment in the public pool. As such, the payoff functions for providers and beneficiaries can be rewritten as follows and are given in equation (15) and (16) respectively:
$$\pi_{i} = \begin{cases} w - g_{Ii} - g_{Pi} + t_{j}, & \text{if either } c_{i} \text{ or } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$

$$\pi_{j} = \begin{cases} w - t_{j}, & \text{if } c_{p} \text{ is reached} \\ 0, & \text{otherwise} \end{cases}$$
(15)
(16)

Similarly, the first order conditions of the maximisation problem facing the provider are given in equations (17) and (18), while that of the beneficiary's problem is given in equation (19):

1

$$\frac{\partial \pi_i}{\partial g_{Ii}} = \begin{cases} 0, & \text{if } g_{Ii} < c_i \\ +\infty & \text{if } g_{Ii} = c_i \\ -1, & \text{if } g_{Ii} > c_i \end{cases}$$
(17)

$$\frac{\partial \pi_i}{\partial g_{Pi}} = \begin{cases} 0, & \text{if } g_{Pi} < c_p \\ +\infty & \text{if } g_{Pi} = c_p \\ -1, & \text{if } g_{Pi} > c_p \end{cases}$$
(18)

$$\frac{\partial \pi_j}{\partial t_j} = \begin{cases} 0, & \text{if } g_{Pi} < c_p \\ +\infty & \text{if } g_{Pi} = c_p \\ -1, & \text{if } g_{Pi} > c_p \end{cases}$$
(19)

The payoff function of the single provider, represented in Figure S4, does not differ from those in the case of passive beneficiaries, except for the potential level effect provided by positive transfer values t_j . In fact, in the absence of the proportional distribution of transfers, positive levels of transfers do not provide monetary incentives for the provider to contribute to the public pool. As such, under the assumption of pure self-regarding preferences, the Nash equilibrium (where $g_{Ii} = c_i$ and $g_{Pi} = 0$) is suboptimal in terms of efficiency and is represented on the figure by point A. The socially efficient optimum (which again entails the minimum aggregate loss) is represented by point B.



Figure S4: Single provider's payoff as a function of her contribution

B.4. Conjectures

T1: Proportional treatment. he optimal individual behavior derived in this treatment relies on the assumption of perfect information and homogeneous self-interested payoff-maximizing preferences for all providers. One can note that in the absence of other-regarding preferences, collective transfers of size $T = \frac{1}{2}c_P = 60$ - which would represent the fair-share solution of sharing the cost of the collective solution equally among providers and beneficiaries - would not be enough to incentivize providers to invest sufficiently in the public pool. One plausible interpretation of this phenomenon entails that providers, who are purely motivated by monetary payoffs, expect to be rewarded for providing the public good of protection from loss to beneficiaries in the form of overcompensation. Given our model specification, beneficiaries are willing to overcompensate providers for their effort since the alternative of losing their full endowment would be worse. As a consequence, compared to the *Control* treatment, the *Proportional* treatment reduces strategic uncertainty through the introduction of monetary incentives for beneficiaries ries to send transfers, and for providers to sufficiently invest into the public pool to protect both from losses.

Conjecture 1: The frequency with which providers establish the collective solution will, on average, be higher in the *Proportional* than in the *Control* treatment.

T2: Pledges treatment. Since pledges are not binding and do not have any monetary consequences, the payoff functions in the *Pledges* treatment are the same as in the *Proportional* one, given in equations (3) and (4). Nevertheless, based on previous literature (as discussed in detail in section 1), we expect pledges to serve as a coordination device to avoid the collective damages.

Conjecture 2a: The frequency with which providers establish the collective solution will, on average, be significantly higher in the *Pledges* condition compared to both *Control* and *Proportional*.

Conjecture 2b: Average transfers by beneficiaries will be significantly higher in *Pledges* compared to *Proportional*.

T3: Single P-B treatment. The resulting predictions include that the single provider chooses the private solution by investing $g_{Ii} = c_i$ at the expense of the beneficiary, independently of the size of transfers t_j . This is because the monetary incentives to contribute to the public solution linked to the proportional distribution of transfers are absent for the provider. See Figure S4 in Appendix B.3 for a graphical representation of the single provider's payoff as a function of contributions. The resulting equilibrium is the same as in the *Control* treatment with passive beneficiaries, barring potential level effects given by positive transfers. Nevertheless, relaxing the assumption of homogeneous, fully self-regarded payoff maximizing individuals, we expect the absence of within-subgroup strategic uncertainty to allow for an easier development of a cooperative reciprocal relationship between the provider and the beneficiary, thus generating a higher likelihood of avoiding the collective damages than in the other treatments.

Conjecture 3: Both the frequency with which providers establish the collective solution and average transfers will be higher in the *Single P-B* condition compared to the other treatments.

C. Extended Results

C.1. Overview of the data

Table S1 provides an overview of the characteristics of participants, in aggregate terms as well as divided by treatment condition.

	All	Control	T1: Proportional	T2: Pledges	T3: Single P-B
Age	22.76	23.30	22.91	22.15	22.52
-	(3.43)	(3.60)	(3.40)	(3.44)	(2.71)
Female (=1)	0.57	0.58	0.53	0.57	0.68
	(0.50)	(0.50)	(0.50)	(0.50)	(0.47)
Donation in last year (=1)	0.39	0.38	0.39	0.39	0.40
	(0.49)	(0.49)	(0.49)	(0.49)	(0.50)
Amount donated (in Euro)	91.21	89.85	112.38	85.41	48.80
	(117.18)	(119.57)	(117.24)	(123.97)	(73.52)
Volunteered in last year (=1)	0.26	0.24	0.25	0.31	0.20
	(0.44)	(0.43)	(0.43)	(0.46)	(0.41)
Hours volunteered	91.52	69.00	115.72	97.31	60.63
	(226.05)	(105.07)	(311.27)	(244.19)	(75.04)
Difficulty group task (0-10)	3.89	3.26	4.14	4.33	3.67
	(2.39)	(2.40)	(2.28)	(2.37)	(2.45)
Time pressure group task (0-10)	2.12	1.86	2.38	2.23	1.82
	(2.46)	(2.37)	(2.62)	(2.38)	(2.50)
Observations	400	120	120	120	40

 Table S1: Balancing of participants characteristics

Note: Mean and standard deviation (in parentheses) are reported for the entire sample and for each treatment group separately.



Figure S5: Graphical overview of average behavior across rounds

Note: Panel A shows the share of collective solutions reached for each treatment group across all 15 rounds. In panel B the providers contributions to the collective solution over treatments are shown. Panel C shows the share of providers that reached the private solution. Lastly, panel D shows beneficiaries' contributions to the transfer pool in Part 2.

Figure S5 shows a graphical overview of the average behavior in each treatment across decision rounds

Table S2 compares the group means of the main outcome variables for each treatment, separating the baseline rounds (Part 1) from those of the treatment rounds (Part 2). The variable c_public (first row of Table S2 and Panel C in Figure S5) gives providers' average individual contribution to the public pool in any given round. We first observe that average contributions to the public pool are noticeably different from both the Nash Equilibrium ($c_p = 0$ in Part 1 for all treatments as well as in Part 2 of *Control* and *Single P-B*, and $c_p = 40$ in Part 2 of *Proportional* and *Pledges*) and the Social Optimum ($c_p = 40$ for all treatments in all periods). The distribution of individual contributions to the public pool for each of the four treatments is displayed in Figure S6.

	Control T1: F		T1: Pro	Proportional T2: Pl		Γ2: Pledges T3. Sing		gle P-B
	Part 1	Part 2	Part 1	Part 2	Part 1	Part 2	Part 1	Part 2
c_public	20.95 (23.04)	15.96 (23.97)	14.26 (21.94)	32.22 (27.52)	19.40 (22.86)	33.57 (20.71)	22.50 (21.93)	26.27 (18.92)
public target reached (=1)	0.13 (0.34)	0.17 (0.37)	$0.09 \\ (0.29)$	$0.39 \\ (0.49)$	0.10 (0.30)	0.51 (0.50)	0.48 (0.50)	$0.62 \\ (0.49)$
individual target reached (=1)	0.70 (0.46)	$0.80 \\ (0.40)$	$0.79 \\ (0.41)$	$0.57 \\ (0.50)$	0.73 (0.45)	$0.49 \\ (0.50)$	$0.62 \\ (0.49)$	0.47 (0.50)
Payoff in round	28.32 (35.00)	35.67 (36.83)	30.55 (35.26)	44.75 (38.00)	26.67 (34.27)	51.21 (36.62)	50.27 (39.38)	62.07 (33.75)
pledged c_public		(.)		(.)		38.97 (14.54)		(.)
transfer		(.)		26.38 (19.48)		25.79 (16.49)		19.99 (13.66)
pledged transfer		(.)		(.)		31.79 (18.89)		(.)
Observations	600	1200	600	1200	600	1200	200	400
# subjects # groups	120 20	120 20	$120 \\ 20$	$ 120 \\ 20 $	120 20	$ 120 \\ 20 $	$\frac{40}{20}$	40 20

Table S2: Summary statistics of outcome variables in each treatment

Note: Mean and standard deviation (in parentheses) are reported for each treatment separately.

Further, the share of times the public threshold was reached (second row of table S2 and Panel A in Figure 2) and all individuals were protected from loss through the public pool is not significantly different between the *Control, Proportional* and *Pledges* treatments in Part 1 (Fisher exact test, all p-values > 0.1, n = 200)³ where it is situated around the 10% mark. The *Single P-B* treatment however, displays a significantly higher proportion than all other treatments, with the public threshold being reached nearly half of the times in Part 1 and 62% of times in Part 2 (Fisher exact test, p-value when comparing to any of the other treatments < 0.0001, n = 200). Given the relatively high frequency with which the public solution is reached already in Part 1 in *Single P-B*, the within-treatment improvement between Part 1 and Part 2 after the introduction of transfers from beneficiaries is of a much smaller magnitude (14 %-points increase, p-value = 0.015, n = 300, Fisher exact test) compared to the *Proportional* and *Pledges* treatments (with increases of 30 and 40 %-points, respectively. Both Fisher exact test p-values < 0.0001, n = 300). There is no statistically significant difference in the *Control* treatment between Part 1 and Part 2 (which are identical in this treatment) (p-value > 0.1, n = 300).

Considering next the proportion of times the individual threshold, c_i , was reached (third row of table S2 and Panel B in Figure 2), that is, the average share of providers privately insured in a group in a round, we find no significant differences between all treatments in Part 1 (with averages between 70% and 79%, all p-values from Fisher exact tests > 0.1, n = 200), except for the *Single P-B* one, where this share is significantly lower (62%, p-values from Fisher exact tests < 0.0001 when comparing to any of the other treatments, n = 200). The within-treatment differences between Part 1 and Part 2 show that the share of privately insured providers increases significantly by 10 %-points in the *Control* treatment (70% to 80%, Fisher exact test p-value = 0.008 and n = 300). For all other treatments on the other hand, this

³ The number of observations is given by the number of units of analysis multiplied by the number of analysis rounds. For example, in this case the analysis unit are groups. We thus have 40 groups (20 per treatment for a comparison between two treatments) multiplied by 5 rounds in Part 1 of the experiment.



Figure S6: Cumulative distributions of contributions to public and private solution

Note: Cumulative distributions of provider's contributions to the collective solution in Part 1 (panel A) and Part 2 (panel B), as well as cumulative distributions of their contributions to the individual solution in Part 1 (panel C) and Part 2 (panel D) are shown

proportion decreases significantly in Part 2: by 22%-points in *Proportional*, 24%-points in *Pledges*, and 15%-points in *Single P-B* (p-values < 0.0001 for *Proportional* and *Pledges*, p-value = 0.008 for *Single P-B*, n = 300).

Average individual per round payoffs (fourth row of Table S2) are not significantly different in Part 1 between the *Control, Proportional* and *Pledges* treatments (both p-values from two-sided t-tests > 0.1, n = 200), and marginally significant between *Proportional* and *Pledges* (p-value = 0.094, n = 200 from two-sided t-test). The *Single P-B* results in significantly higher per round payoffs than all other treatments, by a factor of roughly 20 to 25 %-points (p-value when comparing to any of the other treatments < 0.0001, n = 200 from two-sided t-tests). Additionally, within each treatment there are significant increases in average individual per round payoffs in Part 2 of the experiment. In the *Control* treatment, payoffs increase by roughly 25%, in the *Proportional* treatment by almost 50% and in the *Pledges* one by nearly 100%. Even in the *Single P-B* treatment, in which payoffs were already relatively high in Part 1, payoffs significantly increase by over 20% (p-values from paired t-tests for all treatments < 0.02, n = 40 for *Single P-B* and n = 120 for all other treatments). Overall, average per-round individual payoffs are below the social optimum of 80 for all treatments, and the treatment with payoffs closest to the efficient one is the *Single P-B* one. Individual payoffs in the *Control* treatment are around the predicted Nash Equilibrium average payoff of 35.

	Collective (c_p)		Contributio	ons (g_Pi)	Individual (c_i)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Reduced	Full sample	Reduced	Full sample	Reduced
T3: Single P-B	37.333^{***}	30.408^{***}	4.296	0.735	-12.000^+	-15.037^+
	(7.796)	(7.887)	(3.705)	(3.422)	(6.870)	(7.891)
Obs.	400	380	1000	980	1000	980
Group cluster	80	79	80	79	80	79

 Table S3: Full regression outputs behind Figure 2

Note: As a robustness check we excluded all decisions by providers in the Single P-B treatment which showed understanding issues (neither investing in the private nor public solution or investing in both). Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

	Grouj	p level	Individual	level
	(1) Collective (c_p)	(2) Individual (c_i)	(3) Contributions (g_Pi)	(4) Transfers (t_j)
T1: Proportional	-4.000 (7.497)	9.333 (6.174)	-6.690^+ (3.548)	0.000 (.)
T2: Pledges	-3.000 (6.166)	2.667 (6.597)	-1.547 (3.045)	-0.588 (2.193)
T3: Single P-B	35.000^{***} (9.076)	-8.000 (7.890)	$1.550 \\ (4.170)$	-6.390^{**} (2.689)
Part 2	3.500 (3.784)	10.333^{**} (4.437)	-4.988^{**} (2.086)	
T1: Proportional \times Part 2	26.000^{***} (8.708)	-32.333^{***} (7.404)	22.952^{***} (3.865)	
T2: Pledges \times Part 2	37.500^{***} (7.014)	-34.333^{***} (7.320)	$19.153^{***} \\ (2.910)$	
T3: Single P-B \times Part 2	10.500 (9.511)	-25.833^{***} (8.667)	8.763^{**} (4.242)	
Obs.	1200	3000	3000	1400
Group cluster	80	80	80	60
Test: T1*Part2=T2*Part2 (p-value)	0.24	0.81	0.32	
Test: T1*Part2=T3*Part2 (p-value)	0.19	0.49	0.00	
Test: T2*Part2=T3*Part2 (p-value)	0.01	0.37	0.01	

Table S4: Full regression outputs behind Figure 3

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

Table S5: Full regression outputs behind Figure 4

	Providers (pi_i)		Beneficiaries (pi_j)	Waste		Gini	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Full sample	Reduced	Full sample	Full sample	Reduced	Full sample	Reduced
T3: Single P-B	6.199	15.280^{***}	37.333^{***}	-27.208^{***}	-28.442^{***}	-24.963^{***}	-23.659^{***}
	(4.962)	(3.037)	(7.796)	(4.518)	(4.905)	(2.818)	(3.127)
Obs.	1000	980	1000	400	380	400	380
Group cluster	80	79	80	80	79	80	79

Note: As a robustness check we excluded all decisions by providers in the Single P-B treatment which showed understanding issues (neither investing in the private nor public solution or investing in both). Robust standard errors in parentheses: + p < 0.10, $^{**} p < 0.05$, $^{***} p < 0.05$.

	(1)	(2)	(3)	(4)
	Providers (pi_i)	Beneficiaries (pi_j)	Waste	Gini
T1: Proportional	8.460**	-4.000	-2.788	-2.534
	(3.324)	(7.497)	(4.602)	(3.514)
T2: Pledges	-0.297	-3.000	2.060	-0.453
-	(3.600)	(6.166)	(4.099)	(3.632)
T3: Single P-B	8.920^{+}	35.000***	-27.450***	-25.959***
2	(5.249)	(9.076)	(5.470)	(3.654)
Part 2	11.208***	3.500	-9.193***	-6.955***
	(2.092)	(3.784)	(2.490)	(2.100)
T1: Proportional \times Part 2	-0.868	14.570^{+}	-8.564	-7.478
-	(3.068)	(7.571)	(5.219)	(4.761)
T2: Pledges \times Part 2	10.862***	23.523***	-21.491***	-16.771***
-	(3.510)	(6.142)	(4.635)	(4.024)
T3: Single P-B $ imes$ Part 2	13.207***	-4.325	-5.551	-5.576
	(4.186)	(8.744)	(5.440)	(3.979)
Obs.	3000	3000	1200	1200
Group cluster	80	80	80	80
Test: T1*Part2=T2*Part2 (p-value)	0.00	0.27	0.03	0.09
Test: T1*Part2=T3*Part2 (p-value)	0.00	0.07	0.65	0.73
Test: T2*Part2=T3*Part2 (p-value)	0.61	0.00	0.01	0.02

Table S6: Full regression outputs behind Figure 5

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

D. Additional Analysis

In this section we provide additional analyses that are complementary to the main results presented in section 2. After the detailed descriptive overview of the data in section C.1 we now briefly present average treatment effects using different model specifications in section D.1 and on individuals' expectation ins section D.2. Subsequently, we investigate differences in distributional efficiency and fairness in payoffs between treatments and subject types in section D.3. Finally, section D.4 presents results from a heterogeneity analysis in order to explore the determinants of individual decision making within each treatment, for providers and beneficiaries separately, with a focus on expectations of others' behaviour, conditional reciprocal behaviour and self-reported motivations.



Figure S7: Contributions to the public pool and transfers by groups in Control treatment

Graphs by Unique Group identifier

Figure S8: Contributions to the public pool and transfers by groups in T1:Proportional treatment



Graphs by Unique Group identifier



Figure S9: Contributions to the public pool and transfers by groups in T2:Pledges treatment

Graphs by Unique Group identifier

Figure S10: Contributions to the public pool and transfers by groups in T3: Single P-B treatment



Graphs by Unique Group identifier

Average individual transfers from beneficiaries (row 6 in Table S2 and Panel D in Figure 2) are very similar in the *Proportional* and *Pledges* treatment, and in the *Single P-B* they equal the fair-share level, i.e., half of the average individual contribution necessary to reach the public threshold. Finally, in the *Pledges* treatment, both the mean pledges of providers as well as the mean pledges of beneficiaries are on average higher than their contributions to the public pool and to the transfer account, by 5.4 and 6 %-points respectively (paired t-test p-value < 0.0001 and n = 200 in both cases). The evolution of contributions to the public pool and transfers over rounds can be seen graphically for each treatment and group separately in Figures S7 to S10.

D.1. Average Treatment Effects using different regression model specifications

Table S7 presents results for odds ratios using multilevel logit regressions. Column (1) and column (2) show the odds ratios of reaching the individual and collective solutions respectively for all treatments over *Control*. The results are qualitatively robust to the specifications presented in the main text.

	(1)	(2)
	Collective (c_p)	Individual (c_i)
T1: Proportional	-0.176	0.705
	(0.907)	(0.450)
T2: Pledges	-0.014	0.213
0	(0.662)	(0.406)
T3: Single P-B	2 487***	-0.295
15. oligie 1 D	(0.655)	(0.475)
	(0.000)	(0.110)
Part 2	0.397	0.723^{**}
	(0.424)	(0.329)
T1: Proportional $ imes$ Part 2	1.773^{**}	-2.004^{***}
	(0.895)	(0.490)
T2: Pledges \times Part 2	2.294^{***}	-1.982^{***}
2	(0.629)	(0.447)
T3: Single P-B \times Part 2	0.355	-1.594^{***}
2	(0.637)	(0.531)
Obs.	1200	3000
Group cluster	80	80
Test: T1*Part2=T2*Part2 (p-value)	0.57	0.96
Test: T1*Part2=T3*Part2 (p-value)	0.12	0.46
Test: T2*Part2=T3*Part2 (p-value)	0.00	0.45

Table S7: Robustness check main treatment effects

Note: Multilevel logit regressions with group random effects to account for the strucuture of the data. Estimates are shown as odds ratios. Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

D.2. Average Treatment Effects on expectations

	Beneficiaries expectations about Provider				
	(1) Contributions to public	(2) Investment in private			
T3: Single P-B	-6.477^{**} (2.749)	-0.924 (3.640)			
Obs. Group cluster	1000 80	1000 80			

Table S8: Main treatment effects on beneficiary expectations in Part 1

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

	Beneficiaries expectation	ons about Providers	Providers expectations about Beneficiaries
	(1)	(2)	(3)
	Contributions to public	Investment in private	Transfers
T1: Proportional	-3.950	3.470	0.000
	(2.893)	(2.474)	(.)
T2: Pledges	1.850	-0.547	-3.288
	(2.944)	(2.529)	(2.914)
T3: Single P-B	-7.177^{**}	0.050	-12.958^{***}
	(3.178)	(3.988)	(2.860)
Part 2	-7.485^{***}	-0.093	0.000
	(2.084)	(2.107)	(.)
T1: Proportional \times Part 2	17.142^{***}	-6.738^{**}	0.000
	(3.359)	(2.727)	(.)
T2: Pledges \times Part 2	14.007^{***}	-7.653^{**}	0.000
	(3.054)	(2.898)	(.)
T3: Single P-B \times Part 2	17.220^{***}	-10.957^{***}	0.000
	(3.458)	(3.677)	(.)
Obs.	3000	3000	1400
Group cluster	80	80	60
Test: T1*Part2=T2*Part2 (p-value)	0.36	0.73	
Test: T1*Part2=T3*Part2 (p-value)	0.98	0.22	
Test: T2*Part2=T3*Part2 (p-value)	0.37	0.36	

TADLE 37. MAILE HEALINE III ETIEUS OF EXDECTED CONTIDUTIOUS AND HAUSTER	Table S9: Main treatmen	t effects on e	expected contr	ributions and	transfers
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Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

D.3. Social efficiency and distributional welfare

In this subsection we aim to take a deeper look into the efficiency and distributional dynamics at play in the experiment. Table S10 delves further into the differences in earnings between treatments and between player types illustrated in Figure 4, and reports results from a multilevel regression with the independent variable being the average individual per-round payoff in Part 2 (rounds 6-15). The explanatory variables in column (1) are treatment dummies, whereas in column (2) they also include a binary variable indicating the player type ("provider"), as well as interaction effects of treatment and player type variables.

Firstly, average individual payoffs in Part 2 without player type distinction, reported in column (1), are significantly higher in all three treatments with transfers than in the *Control* treatment (*Proportional* vs *Control*: 9.08 %-points, p-value = 0.005, 95% CI = 2.72 : 15.43; *Pledges* vs *Control*: 15.54 %-points, p-value < 0.0001, 95% CI = 8.47 : 22.62; *Single P-B* vs *Control*: 26.4 %-points, p-value = 0.005, 95% CI = 18.39 : 34.41). Of all three treatments with transfers, *Single P-B* results in highest average payoffs (T1 vs T3, p-value < 0.0001; T2 vs T3, p-value = 0.01), and payoffs in *Pledges* are weakly significantly higher than in *Proportional* (T1 vs T2, p-value = 0.06).

	(1)	(2)
	Payoff in round	Payoff in round
T1: Proportional	9.081**	10.570
	(3.244)	(7.097)
T2: Pledges	15.544^{***}	20.523***
	(3.608)	(7.301)
T3: Single P-B	26.401***	30.675***
	(4.088)	(7.796)
Provider		38.338***
		(7.250)
T1: Proportional $ imes$ Provider		-2.978
		(8.963)
T2: Pledges \times Provider		-9.958
		(8.542)
T3: Single P-B \times Provider		-8.548
		(9.004)
Constant	35.669***	16.500***
	(2.422)	(5.615)
Obs.	4000	4000
Group cluster	80	80
Test: T1×Provider=T2×Provider (p-value)	0.06	0.31
Test: T1×Provider=T3×Provider (p-value)	0.00	0.46
Test: T2×Provider=T3×Provider (p-value)	0.01	0.84

Table S10: Treatment differences in average payoffs across all rounds of Part 2

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

The distance of the average per round payoff from the socially efficient average payoff of 80 (see table ??) gives us a measure of the efficiency for each treatment, i.e., it can be interpreted as the resources "wasted" in terms of potential welfare at each round. For instance, since average per-round payoffs are 9.08 %-points higher in the *Proportional* treatment than in the *Control* one, this corresponds to a $\frac{9.08}{80} = 11.4\%$ increase in efficiency with $1 - \frac{44.75}{80} = 44.1\%$ resources lost,⁴ compared to 55.4% resources lost in *Control*. Similarly, the *Pledges* treatment presents a 19.4% efficiency gain with respect to *Control* with 36% of resources lost, and a 8.1% efficiency gain compared to the *Proportional* treatment. The *Single P-B* treatment is thus the most efficient of all treatments in terms of losses avoided, with only 22.4% resources lost: 13.6% less than in the *Pledges* treatment, 21.7% less than in the *Proportional* one, and 33% less than in *Control*.

Column (2) of table S10 allows us to analyse the distributional effects of treatments among providers and beneficiaries. The first three rows can be interpreted as the welfare gains of beneficiaries in the different treatment conditions with respect to beneficiaries in the *Control* setting without transfers (the intercept, 16.5% of the endowment w = 100). While the coefficient for the *Proportional* treatment is positive, it is not significantly different than that in *Control*. Beneficiaries' average payoffs in both *Pledges* and *Single P-B* are significantly higher than in *Control* (p-value = 0.005, CI = 6.21 : 34.83 for *Pledges*, and p-value

 $[\]overline{44.75}$ is the average individual per-round payoff in Part 2 of the *Proportional* treatment, as shown in table S2.

< 0.0001, CI = 15.39 : 345.96 for *Single P-B*). Overall, however, providers earned significantly more than beneficiaries across all treatments, with a difference of 38.34 %-points in the *Control* treatment (p-value < 0.0001, 95% CI = 24.13 : 52.55). The lack of statistical significance of the three interaction terms in column (2) however, testify how neither of the three treatments contributes to reducing the inequality between providers and beneficiaries. Differently put, the introduction of measures to reduce strategic uncertainty presents significant improvements in terms of welfare efficiency, but do not lead to any gains in terms of distributional fairness: the welfare benefits of reduced strategic uncertainty beneficiaries equally.

D.4. Individual decision making: expectations, pledges and within- and across-subgroup reciprocity

So far, we considered aggregate outcomes between treatments. In this section, we move into the analysis of the determinants of individual decision making of providers and beneficiaries. The aim is to shed light into the mechanisms underlying behavior in each treatment. The determinants of main interest to us are individual expectations (and response to deviation between expected behavior and observed behavior of group members); response to pledges of group members; and overall within- and across-subgroup reciprocity.

D.4.1. Determinants of providers' behaviour

Table S11 reports results from multilevel regression modeling with the independent variable being the individual contributions to the public pool by providers during Part 2 (rounds 6-15) in each treatment separately. Explanatory variables are the previous period's average contribution of the other group members (*L.contribution_others*); having reached the public threshold in the previous period (*L.public target reached*); the average group contribution to the public solution during Part 1 (*avg_c_group_control*); the given round (*round*); the provider's share from the transfer pool in the previous period (*L.provider share from transfer pool*), the absolute positive deviation between expectations of beneficiaries' transfers and beneficiaries' actual transfers, i.e. expecting more than what was offered in a given round (*estimate_diff_positive*); the absolute negative deviation between expectations and transfers offered, i.e. expecting less than what was offered in a given round (*estimate_diff_negative*). Finally, for the *Pledges* treatment, we consider the average pledge of other providers (*pledges_others*) and separately the absolute positive deviation between the gravitation between the public pool (*L.pledge_diff_negative*). Table S12 includes in addition results for the self-reported motivations elicited in the post-experimental questionnaire. See Figure S11 for the frequencies of self-reported motivations between treatments.

	Control	T1: Proportional	T2: Plee	lges	T3. Single P-B
	(1)	(2)	(3)	(4)	(5)
L.contribution_others	0.315^{***} (0.076)	0.168^+ (0.091)	-0.003 (0.087)		
L.public target reached (=1)	$0.581 \\ (5.591)$	$0.530 \\ (4.896)$	-0.314 (3.311)	-2.026 (3.195)	5.062 (4.825)
avg_c_group_control	0.640^{***} (0.097)	0.463^{***} (0.132)	0.309^{***} (0.090)	0.313^{***} (0.086)	$0.195 \\ (0.160)$
Round	-1.395^{***} (0.403)	-0.958^+ (0.512)	-1.209^{**} (0.461)	-1.078^{**} (0.494)	$0.064 \\ (0.488)$
L.Insider share from transfer pool		0.137^{***} (0.042)	0.041 (0.055)	0.063 (0.052)	0.316^{***} (0.101)
estimate_diff_positive		-0.007 (0.066)	-0.090 (0.084)	-0.103 (0.078)	-0.508^{***} (0.158)
estimate_diff_negative		0.447^{***} (0.151)	0.129 (0.133)	$0.100 \\ (0.134)$	-0.007 (0.227)
pledges_others			$0.197 \\ (0.163)$		
L.pledge_diff_positive				-0.147 (0.115)	
L.pledge_diff_negative				-0.220^{***} (0.074)	
Constant	$\frac{11.880^{**}}{(6.030)}$	24.584^{**} (8.949)	32.325^{***} (8.582)	40.550^{***} (6.593)	13.655^+ (7.468)
Obs.	600	540	540	540	180
Group cluster	20	20	20	20	20

Table S11: Determinants of provider's contribution to collective solution in Part 2

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

Firstly, having reached the public threshold in the previous period does not significantly influence provider's future contributions to the public pool in any of the treatments. The average cooperativeness of the group during the baseline rounds of Part 1 is positively and significantly associated with contributions to the public pool in all treatments with multiple providers, but shows no effect in the *Single P-B* treatment. We find a negative time trend in all treatments except in *Single P-B*. Further, the lagged contributions of other providers are only significantly predictive of behavior in the *Control* treatments.

	Control	T1: Proportional	T2: Plee	lges	T3. Single P-B
-	(1)	(2)	(3)	(4)	(5)
L.contribution_others	0.322^{***} (0.076)	$0.156^+ \\ (0.090)$	-0.013 (0.088)		
L.public target reached (=1)	$0.471 \\ (5.641)$	0.925 (4.908)	-0.106 (3.336)	-1.989 (3.188)	3.118 (4.313)
avg_c_group_control	0.413^{***} (0.110)	0.278^+ (0.142)	0.212^+ (0.113)	0.208^+ (0.111)	0.140 (0.087)
Round	-1.387^{***} (0.408)	-0.989^+ (0.506)	-1.206^{**} (0.466)	-1.068^{**} (0.491)	$0.121 \\ (0.498)$
mistrust_ingroup	-1.624 (2.666)	2.883 (2.651)	0.532 (2.247)	0.741 (2.121)	
self-interest	-2.439 (3.968)	-1.364 (5.223)	-2.998 (2.640)	-3.076 (2.484)	-6.766^{**} (3.271)
soc_efficiency	5.649 (3.627)	$6.346 \\ (5.585)$	1.962 (2.699)	2.525 (2.287)	9.687^{**} (3.770)
social_norm	3.245 (2.288)	2.666 (3.777)	3.040 (3.205)	2.805 (2.932)	-8.404^{**} (3.159)
L.Insider share from transfer pool		0.113^{***} (0.035)	0.040 (0.056)	0.064 (0.053)	0.356^{***} (0.111)
estimate_diff_positive		0.019 (0.067)	-0.100 (0.084)	-0.115 (0.077)	-0.636^{***} (0.150)
estimate_diff_negative		0.427^{***} (0.146)	$0.122 \\ (0.141)$	$0.091 \\ (0.142)$	-0.054 (0.199)
low_transfers		-3.043 (4.199)	-2.516 (4.493)	-1.593 (4.001)	2.753 (2.666)
pledges_others			$0.188 \\ (0.171)$		
L.pledge_diff_positive				-0.149 (0.109)	
L.pledge_diff_negative				-0.226^{***} (0.077)	
Constant	14.533^+ (7.539)	25.243^{**} (12.299)	34.740^{***} (9.038)	41.946^{***} (6.478)	17.670^{**} (7.615)
Obs. Group cluster	600 20	540 20	540 20	540 20	180 20

Table S12: Determinants of provider's behavior including self-reported motivations

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

In *Proportional*, higher shares from the transfer pool in the previous period explain higher future individual contributions to the public pool, and being positively surprised by the transfers offered from beneficiaries (that is, higher transfers than expected) is also associated with higher public pool contributions. In *Pledges*, neither the share of transfers received nor expectations of beneficiaries' behavior significantly influence provider's behavior. However, if other provider's contributed more than what they pledged on average in the previous round, this significantly decreases a provider's future contributions. In the *Single P-B* treatment, providers strongly react to the transfers offered to them from beneficiaries. That is, contributions to the public pool increase with higher share of transfers received. At the same time, contributions decrease when the provider expected more transfers than what was offered. Finally, the self-reported motivations only significantly affect behavior in the *Single P-B* treatment. Both self-interest and social norm motivations significantly reduce contributions to the public pool, while social efficiency concerns increase contributions to public pool.

In summary, we find evidence of a reciprocal response from providers to the behavior of beneficiaries in both the *Proportional* and the *Single P-B* decision setting - deviations from expected transfer offers as well as received transfers impact contributions to the public solution. This relationship does not appear in the Pledges treatment, where providers rather respond to deviations from other providers' pledges and actual behavior.

D.4.2. Determinants of beneficiaries' behaviour

Moving to the analysis of beneficiaries' behavior, table S13 reports results from multilevel regression modeling with the independent variable being the individual transfers to the transfer pool by beneficiaries during Part 2 (rounds 6-15) in each treatment separately. Explanatory variables are the previous period's average transfers of the other beneficiaries (*L.transfer_others*); providers having reached the public threshold in the previous period (*L.public target reached*); the absolute positive deviation between expectations of providers' contributions to the public pool and providers' actual contributions in the previous round, i.e. expecting more than what was contributed (*L.estimate_diff_positive*); the absolute negative deviation between expectations and contributions to the public pool in the previous round, i.e. expecting less than what was contributed (*L.estimate_diff_negative*) and the given round (*round*). Finally, for the *Pledges* treatment, we consider again the average pledge of other beneficiaries (*pledge_others_t*) and separately the absolute positive deviation between the previous round's pledges of beneficiaries and actual transfers to the transfer pool (*L.pledge_t_diff_positive*) as well as the absolute negative deviation (*L.pledge_t_diff_negative*). Table S14 includes in addition results for the self-reported motivations elicited in the post-experimental questionnaire.

We find that, in both *Proportional* and *Pledges*, if providers collectively reached the public threshold in the previous period - thereby successfully protecting beneficiaries from loss - this has a negative and significant effect on individual transfers offered in future rounds. On the contrary, having been protected by the single provider in *Single P-B* has a positive significant effect on future transfers. There is a negative time trend on transfers only in the *Pledges* treatment. Pledges of other beneficiaries about transfers positively and significantly increase own transfers. Similarly, if others transferred more than initially pledged, this translates into an increase of individual transfers in future rounds. That is, even though pledges on average did not lead to higher aggregate transfers in the *Pledges* treatment compared to the *Proportional* treatment, beneficiaries seem to use transfers as important signals of other's contribution effort and respond dynamically to them. Finally, the motivation analysis suggests diverse effects dependent on the specific treatment. Mistrust towards the other beneficiaries positively affects transfers in the *Pledges* treatment (consistent with a potential motivation of compensating the insufficient (pledged) transfers of others, trying to sufficiently incentivize providers for public protection), social efficiency concerns positively impact transfers in the *Proportional* treatment, and in *Single P-B* transfers are negatively associated with self-regarding and social norm motivations.

In sum, we find evidence of a negative reciprocal response of beneficiaries to the group of providers' collective protection efforts by reducing transfers, and a positive reciprocal response when interacting instead with a single provider. We find further evidence that beneficiaries positively and significantly react to the transfer pledges of other beneficiaries.



Figure S11: Frequency of motivations between treatments

	T1: Proportional	T2: Plee	dges	T3. Single P-B
	(1)	(2)	(3)	(4)
L.transfer_others	0.127^+ (0.065)	-0.002 (0.050)		
L.public target reached (=1)	-4.810^{**} (1.796)	-6.480^{***} (1.466)	-7.237^{***} (1.273)	5.378^{***} (1.762)
L.estimate_c_diff_positive	-0.167^{**} (0.082)	$-0.156^+ \ (0.081)$	-0.159^+ (0.086)	-0.027 (0.067)
L.estimate_c_diff_negative	-0.043 (0.056)	0.033 (0.070)	$0.053 \\ (0.067)$	-0.056 (0.055)
Round	-0.442 (0.323)	-0.638^{**} (0.285)	-0.733^{**} (0.328)	-0.678 (0.466)
pledges_others_t		0.218^{**} (0.081)		
L.pledge_t_diff_positive			$0.124 \\ (0.110)$	
L.pledge_t_diff_negative			0.280^{**} (0.119)	
Constant	30.922^{***} (5.429)	30.035^{***} (4.893)	37.048^{***} (3.938)	$24.444^{***} \\ (4.663)$
Obs.	540	540	540	200
Group cluster	20	20	20	20

Table S13: Determinants	of beneficiary	's transfers	in Part 2

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

	T1: Proportional	T2: Plee	lges	T3. Single P-B
	(1)	(2)	(3)	(4)
L.transfer_others	0.127^{**} (0.061)	0.017 (0.051)		
L.public target reached (=1)	-4.855^{**} (1.836)	-6.809^{***} (1.449)	-7.461^{***} (1.250)	6.031^{***} (1.965)
L.estimate_c_diff_positive	-0.164^{**} (0.080)	-0.169^{**} (0.075)	-0.171^{**} (0.080)	-0.027 (0.071)
L.estimate_c_diff_negative	-0.038 (0.054)	$0.032 \\ (0.073)$	$0.052 \\ (0.070)$	-0.036 (0.052)
Round	-0.442 (0.319)	-0.636^{**} (0.280)	-0.721^{**} (0.324)	-0.671 (0.468)
mistrust_ingroup	2.935 (3.809)	8.106^{**} (2.916)	8.077^{***} (2.638)	
mistrust_outgroup	-8.134^+ (4.208)	-2.316 (3.744)	-2.112 (3.633)	-3.567 (3.596)
self-interest	2.694 (2.876)	-1.283 (3.111)	-1.517 (3.086)	-6.395^{**} (2.679)
soc_efficiency	6.606^{**} (2.930)	4.719 (3.400)	4.942 (3.268)	$5.353 \\ (3.691)$
social_norm	-2.529 (2.906)	$3.369 \\ (2.757)$	$3.466 \\ (2.596)$	-10.526^{***} (3.473)
pledges_others_t		0.208^{**} (0.080)		
L.pledge_t_diff_positive			$0.107 \\ (0.109)$	
L.pledge_t_diff_negative			0.270^{**} (0.112)	
Constant	$28.346^{***} \\ (6.974)$	22.693^{***} (4.544)	29.733^{***} (3.838)	32.058^{***} (7.017)
Constant	2.746^{***} (0.096)	2.584^{***} (0.106)	2.599^{***} (0.111)	2.392^{***} (0.128)
Obs. Group cluster	540 20	$540\\20$	540 20	200 20

Note: Robust standard errors in parentheses: + p < 0.10, ** p < 0.05, *** p < 0.005.

D.4.3. The role of pledges and expectations for contributions and transfers



Figure S12: Actual contributions, transfers, pledges and expectations

E. Instructions

We first present instructions on Part 1 of the experiment, which was the same for all treatments except the *Single P-B* treatment. We present relevant wording variations for that treatment in italics. We then present instructions for Part 2 of the *Control* and *Proportional* treatment, again with relevant wording variations in italics for all other treatments.

E.1. Instructions Part 1

Welcome & General Rules

Important Information

Dear participant,

Please turn your mobile phone to silent and read the instructions carefully. In this study we will let you make a series of decisions together with other participants. These decisions can influence your payment for this experiment. They can also influence the payment of other participants that take part in this study. The consequences of your decisions in this experiment are real; at the end of the study, the experimenters compute the outcome of the decisions and determine the additional earnings you and the other participants will receive. There is no hidden information and no deception in this study. This means that everything will be executed as stated in the instructions.

This study will take approximately **60 minutes** to complete and you have the chance to earn about **15€** (on average). You will be briefed and trained in the experimental task. Your total earnings will be calculated and paid out at the end of the study. All this will be explained in detail on the next pages.

If you have any questions during the experiment, please raise your hand and we will come to answer your questions privately.

Contact: if you have further questions, complaints or concerns regarding this study, please contact us via mail: [*e-mail address of one of the co-authors responsible for data collection*].

Study Overview

- The study consists of three parts: two group tasks and a survey.
- You will receive a **fixed compensation of 6 \in** for finalizing the study.
- In the group parts, you can earn an additional bonus of up to 22.50€.
- During the study, we use points instead of €, with the exchange rate being: €1.50 = 100 points.
- Please read the following instructions carefully, there will be understanding questions afterwards.

Information Group Part 1

- You will now start with the first group task.
- In the first Part, you will be in a group of 6 participants [For the Single P-B treatment: 2 participants].
- You will not learn about their identity. Likewise, other participants will not learn about your identity. Everything you do in this experiment will be anonymous.
- On the next page, you will be instructed about what you have to do in this part.

General Decision Setting

This part consists of 5 rounds. In each round you and the other group members will receive an endowment of 100 points. 100 points are worth \in 1.50. The points you earned in each round will be exchanged to \in and paid to you in addition to the 6 \in at the end of the study.

However, there is the possibility that you will lose these points.

Who can prevent this from happening?

- There are two types of participants, called Type A and Type B.
- Types are randomly determined and stay the same over all 5 rounds. Thus, there are 3 participants of Type A and 3 participants of Type B.
- Only Type A participants can prevent this from happening.
- Type B participants cannot take any actions to prevent this from happening.

How can Type A participants prevent this from happening?

The first possibility is to invest points into a **private pool**. The *private target* will always be 30 points.

- Each Type A participant has their own private pool that he/she can invest in.
- If a Type A participant invests enough points and reaches the private target, he/she can keep all points that were not invested.
- Type B participants have no private pool to invest in!
- Reaching the private target does only protect this Type A participant from losing his/her points but no one else in their group.
- Every point a Type A participant invests into the private pool will not count towards his/her final payment at the end of the experiment.

The second possibility is to invest points into a **public pool**. The *public target* will always be 120 points [*For the Single P-B treatment*: 40 points].

- The public pool is shared across all Type A participants. That means, that Type A participants can together invest into the public pool to reach the public target.
- Type B participants can not invest into the public pool
- Reaching the public target protects all group members, that is, all Type A and Type B participants in a group.
- Every point a Type A participant invests into the public pool will not count towards his/her final payment at the end of the experiment.

Any points allocated to the **public pool** and **private pool** above the respective targets are not refunded to the Type A participants.

A Type A participant only needs to reach one of the targets (**private** or **public**) to avoid losing remaining points in every given round. This means that Type B participants depend on Type A participants to invest enough to reach the *public target* to avoid losing their endowment.

Decisions to be taken

Type A participants: Each round, a Type A participant is free to keep or invest any amount of their points into the **private** and/or **public pool**. The decision is up to the Type A participant. At the same time, the other Type A participants will make their decision on how to invest points.

Type B participants: Each round, a Type B participant has to estimate how much, on average, Type A participants will contribute to the **private** and/or **public pool** This estimate does not influence anyone's payoff and it will not be shared with other members of the group. All Type B participants have to wait for Type A participants to take their decisions to invest into the **private** and/or **public pool**. A Type B participant cannot invest in either the **private** or **public pool**.

Feedback on current round: After all participants made their decision, you will see the outcome of that round. You will be informed about Type A participants' contributions to the **public pool**. In addition, you will see how much each participant earned. Note that the individual contribution decisions and payoffs will be listed in random order and anonymized at the end of each round. This means, group members will not be able to know the behaviour of specific participants across rounds.

<u>What's next</u>? After learning about the outcome, you can move on to the next round. Both Type A and B participants will again receive an endowment of 100 points and make their decisions. Hence, you will be confronted with the same situation multiple times in the same group for 5 rounds.

Examples

Across the whole Group Part, you will have 100 points as an endowment in each round.

- 1. The *private target* will always be **30 points**.
- 2. The *public target* will always be **120 points**.

Example: The following example will illustrate the rules of this task. This example is for illustrative purposes only and does not represent real decisions by previous participants.

- Participant A1 decides to invest 30 points in his/her private pool and 0 points to the public pool.
- Participant A2 decides to invest 0 points in his/her private pool and 30 points to the public pool.
- Participant A3 decides to invest 0 points in his/her private pool and 50 points to the public pool.

Together, Type A participants invested 80 points in the public pool in total.

In this example, participant A2 and A3 lose their remaining points as they neither reached their *private target* nor the *public target* was reached.

All three Type B participants lose their endowment as the *public target* was not reached.

Only participant A1 keeps his/her remaining points because he/she reached his/her private target.

Earnings of Type A Participants in this example:

Participant	Initial endowment	Contribution to private pool	Contribution to public pool	Private target reached?	Public target reached?	Individual earnings
A1	100	30	0	Yes	No	70
A2	100	0	30	No	No	0
A3	100	0	50	No	No	0

Earnings of Type B Participants in this example:

Participant	Initial endowment	Public target reached?	Individual earnings
B1	100	No	0
B2	100	No	0
B3	100	No	0

Payment

As mentioned before the first group part consists of 5 rounds. At the end of this study after the survey part, you will receive the cumulative earnings from all 15 rounds in addition to the fixed amount for completing the study.

Please make sure you fully understand the rules of this task. Next, we will ask you to answer some comprehension questions to make sure that all participants understand the rules before we start with the first group task.

Press back if you need to review any of the content of the instructions.

If you are ready, please click the "Next" button to begin with the questions. You cannot go back to the instructions.

E.2. Comprehension Questions Part 1

In this section we present the comprehension questions that participants had to answer correctly in order to be able to access the baseline rounds of the game. In the *Single P-B* treatment, questions were identical but formulated in the singular form. As before, we present any other relevant wording variations between treatments in italics.

1) How much I earn in the first part depends on my own behavior.

- a. Correct, independent of my Type (A or B).
- b. Only correct for Type A participants.
- c. Only correct for Type B participants.

2) How much I earn in the first part always depends on the behavior of the other group members.

- a. Correct, independent of my Type (A or B).
- b. Only correct for Type A participants.
- c. Only correct for Type B participants.

3) Both the public target and the private target needs to be reached by Type A participants to be protected from losing their endowment of 100 points.

- a. Correct.
- b. Incorrect.

4) Type B participants can only invest in the public pool but not the private pool.

- a. Correct.
- b. Incorrect.

5) How can Type B participants avoid losing their endowment of 100 points?

- a. By Type A participants reaching their private target.
- b. Type A participants enough in the public pool to reach the public target.
- c. Invest enough to reach the private target themselves.

[For the *Control*, *Proportional* and *Pledges* treatments only:

Please calculate the earnings for the following, hypothetical scenario. The scenario is aimed at testing your understanding of the rules of the task. Remember, every group member has 100 points as endowment, the *public target is 120 points*, and the *private target is 30 points*.

Decisions Type A participants:

- Participant A1 contributed 30 points to his/her private pool, 0 points to the public pool and kept 70 points.
- Participant A2 contributed 0 points to his/her private pool, 60 points to the public pool and kept 40 points.
- Participant A3 contributed 0 points to his/her private pool, 70 points to the public pool and kept 30 points.
- Hence, the type A participants A1, A2, and A3 contributed 0 + 60 + 70 = 130 points to the public pool.

Type B participants (B1, B2, B3) remain passive and do not take any decisions.

1) How many points would participant A1 earn in this round?

2) How many points would participant A2 earn in this round?

3) How many points would participant A3 earn in this round?

4) How many points would participant B1 earn in this round?

]

[For the *Single P-B* treatment only:

Please calculate the earnings for the following, hypothetical scenario. The scenario does not necessarily make sense but is aimed at testing your understanding of the rules of the task. Remember, every group member has 100 points as endowment, the *public target is 40 points*, and the *private target is 30 points*.

Participant A contributed 0 points to his/her private pool, 50 points to the public pool and kept 50 points.

The type B participant remains passive and does not take any decision.

1) How many points would Type A earn in this round?

2) How many points would Type B earn in this round?

]

E.3. Instructions Part 2

E.3.1. *Control* treatment

Information Group Part 2

- In the second group part you will be in a group with the same participants as in the previous five rounds. Everyone in your group, including yourself, keeps their role (A or B) from the first part.
- Thus, you are still a **Type A/B** participant.
- You will still not learn about the other participants' identity. Likewise, other participants' will not learn about your identity. Everything you do in this experiment will be anonymous.
- On the next page, you will be instructed about what you have to do in this part.

Instructions

- This part consists of 10 rounds.
- There are no changes to the rule of the game. In each of the 10 rounds you and the other group members will receive again an endowment of 100 points. 100 points are worth €1.50
- At the end of this study after the survey part, you will receive the cumulative earnings from all 10 rounds in addition to the earnings from part 1 and the fixed amount for completing the study.

E.3.2. Treatments with transfers

Information Group Part 2

- In the second group part you will be in a group with the same participants as in the previous five rounds. Everyone in your group, including yourself, keeps their role (A or B) from the first part.
- Thus, you are still a Type A/B participant.
- You will still not learn about the other participants' identity. Likewise, other participants' will not learn about your identity. Everything you do in this experiment will be anonymous.
- On the next page, you will be instructed about what you have to do in this part.

General Decision Setting

- This part consists of 10 rounds.
- In each of the 10 rounds you and the other group members will receive again an endowment of 100 points. 100 points are worth €1.50
- At the end of this study after the survey part, you will receive the cumulative earnings from all 10 rounds in addition to the earnings from part 1 and the fixed amount for completing the study.
- For the second part, there are some changes to the rules of the game as explained on the next pages.

There is still the possibility that you will lose your endowment of 100 points in any given round.

Decisions to be Taken

Decision: Type B participants

In every round, each Type B will make the following choices: [*For the Pledges treatment only:* (1) promise on transfers] (2) decisions on transfers, and (3) estimate type A behavior.

[For the Pledges treatment only: 1. Promise:

- Type B participants can now support Type A participants to make contributions to the **public pool** by contribution to the **transfer pool**.
- Each Type B participant will have to promise how much they are going to contribute to the **transfer pool** before actual transfers.
- These promises will be shown to the other Type B participants before they take their transfer decision.
- The promise is not binding, each Type B participant is free to contribute whatever they like to the transfer pool.]

2. Transfer:

- [For the Proportional and Single P-B treatments only: Type B participants can now support Type A participants to make contributions to the **public pool** by contribution to the **transfer pool**.]
- Type B participants take their decisions before Type A participants. [*For the Proportional and Pledges treatments only:* Type B participants are free to keep or invest any amount of their points into the **transfer pool**.]
- For Type A participants to receive transfers from the transfer pool, they need to have protection through either the private or public pool. That is, Type A participants might lose their transfers, unless they are protected.
- [For the Proportional and Pledges treatments only: The amount each Type A participant receives from the transfer pool will depend proportionally on how much he/she contributed to the public pool.
- If a Type A participant is the only one contributing to the public pool, he/she will get all transfers. If a Type A participant does not contribute anything to the public pool, and the others do, he/she will get nothing from the transfer pool. Only if all Type A participants contribute nothing, they receive an equal share from the **transfer pool**.]
- Type A participants will learn about the total size of the **transfer pool** before deciding to keep or invest any amount of their points into the **private** and/or **public pool**.

3. Estimate:

- Type B participants have to estimate how much, on average, Type A participants will contribute to the **private** and/or **public pool**.
- The estimates do not influence payoffs of any group member, and they will not be shared with other members in the group.

Decision: Type A participants

In every round, each Type A will make the following choices: [*For the Pledges treatment only:* (1) promise on contribution to the public pool,] (2) estimate of Type B transfers and (3) contributions to the public and private pool.

[For the Pledges treatment only:

1. Promises:

- Each Type A participant will have to promise how much they are going to contribute to the **public pool** before taking their actual contribution decision.
- These promises will be shown to the other Type A participants in the group before they take their contribution decision.
- The promise is not binding, each Type A participant is free to contribute whatever they like to the **public pool**.]

2. Estimate:

- Type A participants have to estimate how much, on average, Type B participants will contribute to the **transfer pool**.
- The estimates do not influence payoffs of any group member, and they will not be shared with other members in the group.

3. Contributions:

- Type A participants learn about the total size of the **transfer pool** [*For the Pledges treatment only:* and promises of contributions to the public pool by other Type A participants].
- Then, Type A participants are free to keep or invest any amount of their points into the **private** and/or **public pool**.
- [For the Proportional and Pledges treatments only: Notice that the share from the transfer pool will depend on contributions by Type A participants to the **public pool**. This means that the share of transfers a Type A participant receives, depends on his/her individual contribution to the public pool relative to the total contributions to the public pool by all Type A participants in your group.]
- The transfer pool should be viewed as a way for Type B participants to support Type A participants' contribution to the public pool.

Feedback on every round:

- Type A participants contributions to the **public pool**.
- Type B participants contributions to the **transfer pool**.
- In addition, Type A participants will learn their share of transfers (if protected).
- Earnings of each participant in your group.

Note that the decisions and earnings will be listed in random order and anonymized at the end of each round. This means, group members will not be able to know the behaviour of specific participants across rounds.

<u>What's next</u>? After learning about the outcome, you can move on to the next round. Both Type A and B participants will again receive an endowment of 100 points and make their decisions. Hence, you will be confronted with the same situation multiple times in the same group for 10 rounds.

Example

Across the whole Group Part, you will have 100 points as an endowment in each of the 10 rounds.

- The private target will always be **30 points**.
- The *public target* will always be **120 points**.

Example: The following example will illustrate the rules of this task. This example is for illustrative purposes only and does not represent real decisions by previous participants.

[For the Proportional and Pledges treatments only:

- Participant B1 decides to invest 30 points to the transfer pool.
- Participant B2 decides to invest 20 points to the transfer pool.
- Participant B3 decides to invest 10 points to the transfer pool.
- Together, Type B participants contributed 60 points in the transfer pool in total.
- Participant A1 decides to invest 30 points in his/her private pool and 0 points to the public pool.
- Participant A2 decides to invest 0 points in his/her private pool and 30 points to the public pool.
- Participant A3 decides to invest 0 points in his/her private pool and 50 points to the public pool.
- Together, Type A participants contributed 80 points in the public pool in total.

In this example, participant A2 and A3 lose their remaining points as they neither reached their *private target* nor the *public target* was reached.

All three Type B participants lose their endowment as the *public target* was not reached.

Only participant A1 keeps his/her remaining points (nothing from the **transfer pool**, no contribution to **public pool**) because he/she reached his/her *private target*.

Earnings of Type A Participants in this example:

Participant	Initial endowment	Contribution to private pool	Contribution to public pool	Private target reached?	Public target reached?	Share from transfer pool (if protected)	Individual earnings
A1	100	30	0	Yes	No	0	70
A2	100	0	30	No	No	(30/80)*60=22.5	0
A3	100	0	50	No	No	(50/80)*60=37.5	0

Earnings of Type B Participants in this example:

Participant	Initial endowment	Contribution to transfer pool	Public target reached?	Individual earnings
B1	100	30	No	0
B2	100	20	No	0
B3	100	10	No	0

]

[For the Single P-B treatment only:

- Participant B decides to invest 30 points to the transfer pool.
- Participant A decides to invest 30 points in his/her private pool and 0 points to the public pool.

In this example, the Type B participant loses their endowment as the *public target* was not reached.

Type A participant keeps his/her remaining points as well as the points in the **transfer pool**, because he/she reached their *private target*.

Earnings of A in this example:

Participant	Initial endowment	Contribution to private pool	Contribution to public pool	Private target reached?	Public target reached?	Share from transfer pool (if protected)	Individual earnings
А	100	30	0	Yes	No	30	100

Earnings of B in this example:

Participant	Initial endowment	Contribution to transfer pool	Public target reached?	Individual earnings
В	100	30	No	0

]

As mentioned before the second group task consists of 10 rounds. At the end of this study after the survey part, you will receive the cumulative earnings from all 10 rounds in addition to the earnings from the first part and the fixed amount for completing the study.

Please make sure you fully understand the rules of this task. Next, we will ask you to answer some comprehension questions to make sure that all participants understand the rules before we start with the second group task.

If you are ready, please click the "Next" button to begin with the questions. You cannot go back to the instructions.

E.4. Comprehension Questions Part 2

1) How much I earn in the second part depends on the behaviour of the other group members.

- a. Correct, for both Type A and B participants.
- b. Only correct for Type A participants.
- c. Only correct for Type B participants.

2) The share that Type A participants receive from the transfer pool depends on how much they contribute into the public pool.

- a. Correct.
- b. Incorrect.

3) If a Type A participant is not protected through either the private or the public pool, can she receive any transfers?

a. Yes.

b. No.

[For the *Pledges* treatment only:

4) Type A and Type B participants must contribute the same as they promised to the public or the transfer pool respectively.

- a. Correct.
- b. Incorrect.

]

[For the *Control*, *Proportional* and *Pledges* treatments only:

Please calculate the earnings for the following, hypothetical scenario. The scenario is aimed at testing your understanding of the rules of the task. Remember, every group member has 100 points as endowment, the *public target is 120 points*, and the *private target is 30 points*.

Decisions Type B participants:

- Participant B1 contributed 30 points to the transfer pool and kept 70 points.
- Participant B2 contributed 20 points to the transfer pool and kept 80 points.
- Participant B1 contributed 10 points to the transfer pool and kept 90 points.
- Hence, type B participants contributed 60 points to the transfer pool in total.

Decisions Type A participants:

- Participant A1 contributed 30 points to his/her private pool, 0 points to the public pool and kept 70 points.
- Participant A2 contributed 0 points to his/her private pool, 60 points to the public pool and kept 40 points.
- Participant A3 contributed 0 points to his/her private pool, 70 points to the public pool and kept 30 points.
- Hence, the type A participants A1, A2, and A3 contributed 0 + 60 + 70 = 130 points to the public pool.

Shares from transfer pool (total size of 60 points) Type A participants:

- Participant A1: 0 points.
- Participant A2: (60/130)*60=28 points.
- Participant A3: (70/130)*60=32 points.

1) How many points would participant A1 earn in this round?

2) How many points would participant A2 earn in this round?

3) How many points would participant A3 earn in this round?

4) How many points would participant B1 earn in this round?

]

[For the *Single P-B* treatment only:

Please calculate the earnings for the following, hypothetical scenario. The scenario does not necessarily make sense but is aimed at testing your understanding of the rules of the task. Remember, every group member has 100 points as endowment, the *public target is 40 points*, and the *private target is 30 points*.

Participant A contributed 0 points to his/her private pool, 50 points to the public pool and kept 50 points.

1) How many points would Type A earn in this round?

2) How many points would Type B earn in this round?

]

E.5. Survey questionnaire

A survey questionnaire was used at the end of the experiment to elicit participants' basic demographics, preferences and beliefs. Again, differences between treatments are explained in italics.

Survey

To **finish the study**, please **answer a few questions** about yourself. Following this, you will be presented with your bonus payment results.

The answers in this section of the study do not affect your bonus payment. However, you are only eligible to receive the reward for submission and your bonus if you finish this second section of the study as well. All of your answers will be kept confidentially and will only be used in aggregate. None of the following questions can be used to identify you.

Please enter your age.

Please select your gender.

 \odot Male \odot Female \odot Other \odot I prefer not to say

Did you donate to any charity in the last 12 months?

○ Yes ○ No

If yes, how much in total to all charities (approx.)?

Have you volunteered for any charity in the last 12 months?

○ Yes ○ No

If yes, how many hours in total for all charities (approx.)?

[For *Providers (Type A participants)* only:

Think about your decision regarding your contributions to the **public pool** and **private pool**. Why did you decide to contribute as much as you did? Please indicate on a scale from 1 "Strongly disagree" to 5 "strongly agree" to what degree you agree with the following statements:

[For the *Control*, *Proportional* and *Pledges* treatments only:

I followed the example in the instructions. Type A participants that reached the *private target* earned higher payoffs.

Strongly disagree O------O Strongly agree

I did not trust much the other Type A participants. I did not expect them to contribute much to the public pool.

Strongly disagree
] I contributed as much as I did to ge the highest payoff for myself. I contributed as much as I did because I cared about the Type B participants. Strongly disagree I felt the responsibility to contribute to the public pool so I would not let Type B participants down. Strongly disagree O-----Because contributing to the public pool is the right thing to do, [For the Control, Proportional and Pledges treatments only: irrespective of what the participants in my group did]. Strongly disagree I did not understand the decision task of Type A participant. Strongly disagree O -----0-----[For the *Proportional*, *Pledges* and *Single P-B* treatments only: I thought that the contributions of Type B participants to the transfer pool were not high enough. Strongly disagree]] [For *Beneficiaries (Type B participants)* of the *Proportional, Pledges* and *Single P-B* treatments only: Think about your decision regarding your contribution to the transfer pool. Why did you decide to contribute as much as you did? Please indicate on a scale from 1 "Strongly disagree" to 5 "strongly agree" to what degree you agree with the following statements: [For the *Control*, *Proportional* and *Pledges* treatments only: I followed the example in the instructions. Type B participants that contributed less to the transfer pool earned higher payoffs. Strongly disagree I did not trust much the other Type B participants. I did not expect them to contribute much to the transfer pool. Strongly disagree O-----O-Strongly agree] I contributed as much as I did to ge the highest payoff for myself.

Strongly disagree O				
I did not expect contributions to to the public pool.	the transfer po	ol to increase	the contribution	ns by the Type A participants
Strongly disagree O	0			
I felt the responsibility to contribute to the transfer pool [For the <i>Control</i> , <i>Proportional</i> and <i>Pledges</i> treat- ments only: so I would not let the other participants in my group down].				
Strongly disagree O				Strongly agree
Because contributing to the transfer pool is the right thing to do, [For the <i>Control</i> , <i>Proportional</i> and <i>Pledges</i> treatments only: irrespective of what the other Type B and A participants did].				
Strongly disagree O		O		
I did not understand the decision task of Type B participant.				
Strongly disagree O	0	0		
To get the highest payoff for the v and Type A participants.	vhole group, b	ooth for Type B	[For the Single	<i>P-B</i> treatment only: for me]
Strongly disagree O				Strongly agree
I wanted to contribute some to th	e transfer pool	but also save	some.	
Strongly disagree O		0		Strongly agree
]				
Feedback Please briefly describe how you decided on your contribution to the public pool. Did you associate today's task with a situation that people encounter in their lives? If yes, please describe the situation briefly				
How difficult was it to understand today's task? Please choose a value on the scale below, where 0 means 'Very easy' and 10 means 'Very difficult'.				
0 = Very easy				
To what extent did you feel time pressure during today's task? Please choose a value on the scale below, where 0 means 'Not pressured at all' and 10 means 'Extremely pressured'.				
0 = Not pressured at all				

Do you have any further comments on the study?

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Ivo Steimanis, Natalie Struwe, Julian Benda, Esther Blanco

Reducing strategic uncertainty increases group protection in collective risk social dilemmas

Abstract

Interrelated global crises - climate change, pandemics, loss of ecosystem services and biodiversity - pose risks that demand collective solutions. Uncertainty about others' behavior, coupled with the dependence on some to take collective efforts to mitigate risks for all (e.g. conservation of natural habitats by those living at wildlife boarders to reduce risk of zoonoses), complicates collective action. We extend the experimental collective risk social dilemma to consider that some individuals ('beneficiaries') cannot protect themselves and must rely on others ('providers') for collective protection. Our approach allows to disentangle the relevance of self-interest and uncertainty over the actions of others in explaining self-reliance by providers. Our findings show that reducing strategic uncertainty leads to more collective solutions, with more beneficiaries protected, less resources wasted, and lower inequality. Moreover, we show that institutions inspired by payments for ecosystem services that allow beneficiaries to make compensation transfers to providers of protection are highly effective in fostering collective solutions. Indeed, these voluntary institutions are similarly effective in alleviating the social dilemma as (the hypothetical case of) fully removing strategic uncertainty. Thus, we show that understanding the reasons for self-reliance in collective risk social dilemmas can help develop better institutions to enhance the use of collective solutions, and thereby enhancing social welfare.

ISSN 1993-4378 (Print) ISSN 1993-6885 (Online)