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ORIGINAL PAPER

Bygones in a public project

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Abstract
The experimental literature suggests that contributions to a public good made dynamically, over multiple stages are higher than contributions made in a static setting, even when players do not receive feedback about co-players' previous contributions between stages. Because the dynamic setting without feedback is strategically equivalent to the static one, this finding is puzzling. One important difference between the two settings, however, is that the dynamic setting gives the opportunity to sink contributions while in the static one this opportunity does not exist. I test whether the sunk character of the dynamic contributions explains the higher contributions in the dynamic setting. Symmetric players contribute in two stages to a threshold public good and receive feedback after each stage. The experimental treatment differ in whether the first-stage contributions are sunk or not when deciding on the second-stage contributions. The results show that making the first-stage contributions sunk increases the second-stage individual contributions, and this is more so the case at higher levels of the first-stage contributions. This suggests that the sunk contributions do, at least partially, explain the better performance of the dynamic setting.

1 Introduction

Contributions to a public good that are made in incremental amounts over a period of time are very prevalent in real life, including donations to charities and even countries' contributions to mitigating climate change. For example, in the context of the Paris Agreement, countries take stock of their contributions every five years and set new target contributions for the next five years. This stock-taking every cycle of five years is equivalent to a round of play in which information over the incremental contributions of the co-players becomes available. The targets for the next cycle of 5 years are non-binging pledges, while the actual contribution efforts are yet to be made during the next round of five years. Therefore, the setting of the

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Paris Agreement can be seen as a dynamic game in which contributions are made in increments to reach a threshold of contributions, i.e. the level of emissions that will keep the temperature below the famous two degrees celsius target.

This dynamic contribution setting allows players to condition their contributions on the contributions made by other players in the past. This is in contrast to the static setting in which the contributor makes a single contribution decision simultaneously with other players' contributions. The experimental literature on dynamic contributions games suggests, directly or indirectly, that total contributions in a dynamic setting exceed the contributions in the static one (Duffy et al. 2007). One explanation for this is provided by Schelling (1960), who argues that incremental contributions allow co-players to test each others' trustworthiness for a small price. This hypothesis has been experimentally tested by Duffy et al. (2007) who find that contributions made dynamically without feedback between the contribution rounds are statistically equal to those made in a dynamic setting with feedback; however, they are significantly higher than those made in a static setting. This finding is puzzling because the dynamic contribution setting without feedback is theoretically equivalent to the static setting and, therefore, the contributions in these settings should not differ from one another.

What is, nevertheless, the common feature between the dynamic settings with feedback and the dynamic setting without feedback is the sunk character of the contributions made in previous rounds of play. In the static setting, on the other hand, there is no opportunity to sink contributions. If some contributions are already sunk, a rational decision maker disregards them, such that current contributions are independent of past contributions. This, in turn, leads to more subsequent contributions especially when a target overall contribution is set, as is the case with a threshold public good. Unfortunately, Duffy et al. (2007) only report how individuals condition their contributions on co-players' past contributions, but not how they condition their contributions on their own past contributions. Therefore, it is not possible to make conclusions regarding individual responses to sunk contributions.

In this paper I test whether it is the individual rationality rather than, or in addition to, the conditionality on others' behavior that explains the higher production of the public good in the dynamic setting compared to the static one.[1] In particular, I ask if the sunk individual contributions can explain the better performance of the dynamic setting in collecting contributions to goods that are provided only if a threshold is met. For this I set up an experiment in which subjects make contributions over two stages to a threshold public good. The experimental treatments differ with respect to the action space available in the second stage. In one treatment subjects have the option to withdraw the contributions made in the first stage, in part or entirely. This amounts to the possibility of making negative contributions in the

[1] Assuming that subjects have the intention to participate in providing the public good and, thus, make early contributions, the failure of continuing to participate is a manifestation of the fallacy of sunk costs. If the fallacy is observed, the situation is similar to the one in which a competitive firm exits the market prematurely, when the price is above the average variable cost, but below the average total cost. In the short run the fixed costs, which are included in the total costs, are sunk.

second stage and it means that the first-stage contributions are not sunk. In the second experimental treatment subjects cannot withdraw their first-stage contributions and can only make null or strictly positive contributions in the second stage. Hence, the first-stage contributions are sunk.

Because the purpose is to test whether the sunk character of the first stage individual contributions induces higher subsequent contributions, equal conditions should be ensured in the first stage. This is achieved by providing subjects with the same information before the first-stage contributions are decided. In particular, in the *no-information* condition the participants know that the option to withdraw the first-stage contributions occurs with 50% probability and that it is equally likely that they cannot withdraw these contributions in the second stage. As a control I include an *information* condition in which participants know before making their first-stage contributions whether these can be withdrawn or not in the second stage. Thus, the experimental design keeps the dynamic character of the contribution decisions, which was made responsible for the higher contributions by the previous literature, but it isolates the effect of the sunk or non-sunk character of these contributions.

The results show that the second-stage contributions are, indeed, higher when the first-stage contributions are sunk as compared to when they are not sunk, in both informational conditions. Moreover, the difference in the second-stage contributions between the sunk and the non-sunk treatments increases with the amount contributed in the first stage for both informational conditions and more so for the no-information condition. This is evidence that players respond positively to their own sunk contributions. Thus, these results support the hypothesis that the opportunity to sink contributions in the dynamic setting explains, at least partially, its better performance relative to the static one. However, in this experiment I do not find evidence of sunk contributions improving the provision of the public good. In particular, I fail to find statistical evidence that the total group contributions or the project's success rates differ across treatments. However, this result does not invalidate the fact that individual player's response to own sunk contributions may explain the better performance of the dynamic setting. Recall that in the setting of this experiment both treatments have a dynamic nature and although the static setting and the no-sunk treatments are theoretically equivalent, there may be behavioral differences which are not the objective of this paper.

Finally, contrary to Duffy et al. (2007), I do not find evidence of subjects conditioning their contributions on the previous contributions of their co-players. However, I find that a player's contribution in the second stage increases in her expectations about her co-players contributions in the same stage. This effect is stronger and statistically significant in the "no information" condition, showing that the beliefs about other players' contributions substitutes for some of the uncertainty present in this informational condition.

The remainder of the paper is organized as follows as follows. The next section discusses the related literature. Section 3 outlines the experimental design, the theoretical predictions and the hypotheses to be tested. In Sect. 4 present the results, using both non-parametric tests and regression analysis. Section 5 concludes and discusses the limitations of the study.

2 Related literature

As explained above, this paper is motivated by the finding of Duffy et al. (2007) who set up an experiment to test two hypotheses that explain why the dynamic public-good game provides higher contributions than the static one. The two hypotheses are the "small-price-of trust" hypothesis (Schelling 1960, pp. 45–46) and the condition that a jump in payoff should exist at the completion point (Marx and Matthews 2000). While the authors find that the dynamic game leads to higher contributions than the static one, they also find that none of the above hypotheses explains this result. Moreover, a dynamic game without feedback about the group's contribution between the contribution rounds, yields higher contributions than the static one, but similar to the dynamic contributions with feedback. Similar conclusions emerge from Dorsey (1992) when comparing their real-time contribution environment with a provision point with the static one of Isaac et al. (1989). Using a provision point mechanism, in which the public good is binary and the contributions are all-or-nothing, Goren et al. (2003, 2004) also conclude that a real-time protocol of play provides higher contributions than the static play. In a real-time provision environment players can make contributions at any time during a time window. Hence, not only are the contributions dynamic, but the order and timing of the contributions are determined endogenously by the players themselves. Thus, this is different from the dynamic setting used in the current paper.

An important feature relevant for the current study is that the above-mentioned papers study dynamic contributions with and without the possibility to withdraw previously-made contributions. Specifically, Dorsey (1992) compares these contribution institutions both for a linear payoff function and for a payoff function with a jump at the provision point. The author finds no significant difference between the two institutions for neither of the payoff functions, although contributions are higher when there is no possibility to withdraw (in the language of the current paper, the previous contributions are sunk). By contrast, the real-time reversible contributions in Goren et al. (2004) reach the provision threshold significantly less often than in Goren et al. (2003) in which already-made contributions remain sunk (Goren et al. 2004). However, the difference with Dorsey (1992) and with the current study is that the contribution decisions are constrained to be binary, i.e. contribute all endowment or nothing. Battaglini et al. (2016) also study experimentally the effect of the reversibility versus irreversibility of contributions to a dynamic non-linear public good. They find that the setup with irreversible contributions leads to a higher production of the public good than the reversible-contributions setup, although contributions decline over time in both environments. Similar conclusions are reached by Kurzban et al. (2001) who use an environment with real-time contributions to a linear public good game.

These papers, however, differ in at least three main respects from the current study. First, in Dorsey (1992) and Goren et al. (2003, 2004) contributions are made in continuous rather than in discrete time. While the continuous time setting may be more realistic, the discrete time protocol implemented in the current study eliminates issues related to reaction to last-second decisions and attention to status updates, allowing to identify the pure effect of sunk contributions. Second, in Goren et al. (2003, 2004) contributions are binary, thus considerably limiting the actions space of the players. Using continuous contributions instead, allows studying the effect of the previous sunk contributions on the subsequent ones, both in the direction of increased and decreased contributions. Third, the games played in Battaglini et al. (2016) and Kurzban et al. (2001) differ considerably from the game of the current paper, of which the type of the public good and the payoff functions, hence the equilibria, are the most notable differences. The choice of a threshold public good game in this paper is explained in Sect. 3.

The literature that studies the effect of seed money, i.e. money that are already collected before asking contributions from donors, also bears similarities with the current paper, to the extend that the first-stage contributions can be regarded as seed money from the perspective of the second stage. For example, testing a previously advanced theory, List and LuckingReiley (2002) conduct a threshold public good field experiment in which their three treatments differ with respect to the percentage of the threshold that represents the seed. Indeed, they find that contributions and participation to the donation campaign increase monotonically in the amount of seed money. Bracha et al. (2011), on the other hand, find that seed money provided by a first-mover in a sequential contribution game does not have a positive effect on individual contributions, but it increases the likelihood of provision if the threshold is sufficiency high. Donazzan et al. (2016) also find a positive effect of seed money on participation, but find no effect of seed money on the average donation size, similar with Verhaert and den Poel (2012) and Rondeau and List (2008). Nevertheless, the channels through which seed money affects contributions, most notably through reciprocity and trust, differ from the ones investigated in the current paper. This is because seed money is a prior contribution provided by other donors and not by the solicitee herself. By contrast, the experiment of this paper investigates the effect of the contributions made by a donor in the past on her own current contributions.

Finally, the literature that investigated sequential contributions environments in which players contribute to the public good in turns is also somewhat related to the current study. This literature has studied the effect of the information about the history of play available to the players (e.g. Erev and Rapoport 1990; Steiger and Zultan 2014), the role of refunds in a threshold public good game (Coats et al. 2009) or the role of players' asymmetry (Gächter et al. 2010). It should be noted however, that while the sequential setting has a dynamic character in the sense that players have the chance to observe the behavior of the co-players before making their decisions, this is different from the notion of dynamism used in this paper. In the dynamic game used in this experiment players make sequential decisions in stages, but in each stage all players make simultaneous decisions.

Table 1 Summary of the experimental treatments

Treatment	Information condition	
	Information	*No* information
First-stage contributions are sunk	*Info-Sunk*	*NoInfo-Sunk*
First-stage contributions are *not* sunk	*Info-NoSunk*	*NoInfo-NoSunk*

3 Experimental design

Groups of n symmetric players contribute simultaneously over two stages to a threshold public good, with T denoting the provision point. Each player has the same endowment of play w, from which she can make contributions to the threshold public good. The good is provided if the sum of all players' contributions over the two stages exceeds the provision point, in which case every player receives a bonus B, regardless of her contribution. There is no refund of the contributions made over the two stages if the threshold is not reached or if it is over-reached.

The choice of a threshold public good for this experiment has a two-fold motivation. First, it allows for comparisons with the previous literature that motivates the current research and which also uses threshold public good games to compare dynamic and static contributions settings. Second, the nature of the research question makes the threshold public good game the appropriate game. This is because it allows for a straightforward derivation of player's best response in the second stage and thus, for clear predictions of behavior both with and without sunk contributions, as it will become clear below. Moreover, while the previous literature has employed several rounds of contributions (e.g. in Duffy et al. (2007) the dynamic setting treatment has four stages of contributions), for the purpose of the current paper, in which the response to own sunk contributions is searched for, employing only two rounds of contributions has the advantage of making the actual response to own past contributions more clear-cut, by reducing the multiplicity of equilibria. A further advantage is reflected in the data analysis because it allows the tested hypotheses to be directly derived from the theoretical predictions, as it is shown in Sect. 3.1.

The experimental treatments differ in two dimensions. First, in order to identify the effect of the sunk contributions, the groups differ in whether the first-stage contribution is sunk or not when players decide on their second-stage contribution. I label these treatments *Sunk* and *NoSunk*, respectively. Thus, in the *Sunk* treatment players can only make weakly positive contributions in the second stage, while in the *NoSunk* treatment they can also withdraw fully or partially the contributions made in the first stage by making negative contributions. Second, in order to isolate the pure sunk-contribution effect, the first-stage contributions should be identical between the two conditions. This is achieved by providing the same information before the first-stage contributions, i.e. players know their second-stage contribution options of withdrawing the first-stage contribution or not only after the first-stage contributions are completed. Before they make their first-stage contributions, players know the two possible second-stage options and that each of them has equal chance of being realized. This is the no-information condition which will be labeled *NoInfo*. As a control, in the information condition, labeled *Info*, players know their second-stage options with certainty before making their first-stage contributions. This yields the two-by-two design summarized in Table 1.

In what follows I continue to refer to the differences regarding the first-stage contributions being sunk or not as *treatments* and at the differences along the ex-ante information as *(informational) conditions*. In all treatments and conditions, players are informed about each players' individual contributions, as well as about the total group contributions after the first stage. In fact, the history of the first-stage contributions is available to the players while making their second-stage contributions.

3.1 Theoretical analysis and parameters

Let g_i^t be the contribution of player $i \in \{1, \dots, n\}$ in stage $t \in \{1, 2\}$. Then, the individual payoff of player i is given by:

$$U_i(G_i, G_{-i}, T) = w - G_i + r(G_i + G_{-i}), \text{ with } G_i = g_i^1 + g_i^2, \tag{1}$$

where G_{-i} is the total contribution to the public good over the two stages by all players except for player i. Hence, $G_i + G_{-i}$ is the total contribution of the group to the public good. Finally, function

$$r(G_i + G_{-i}) = \begin{cases} B, & \text{if } G_i + G_{-i} \geq T \\ 0, & \text{if } G_i + G_{-i} < T \end{cases} \tag{2}$$

is the individual return to the public good.

I further focus on subgame perfect Nash equilibria. In the static version of the game, the best response of player i to the total contribution by the other players is given by:

$$g_i(G_{-i}) = \begin{cases} T - G_{-i}, & \text{if } T - G_{-i} \leq \min\{B, w\} \\ 0, & \text{otherwise} \end{cases}.$$

Let us now analyze the best-response function of player i to the contributions of the other players in the second stage, both when players can withdraw and when they cannot withdraw the first-stage contributions. I denote by $G^t = \sum_{i=1}^n g_i^t$ the total group contribution made in stage $t = 1, 2$ and by $G_{-i}^t = \sum_{j=1, j \neq i}^n g_j^t$ the total contribution made in stage t by all players expect for player i.

The *NoSunk* treatment, in which players can withdraw their first-stage contributions, is equivalent with the static game. Therefore, player i completes the projects only if her total contribution over the two stages does not exceed the value of the project B, and withdraws her first-stage contribution otherwise. Formally, accounting for the budget constraint, her best-response function for the contribution in the second stage is given by:

$$g_i^2(G_{-i}^2) = \begin{cases} T - G^1 - G_{-i}^2, & \text{if } T - G^1 - G_{-i}^2 \leq \min\{B - g_i^1, w - g_i^1\} \\ -g_i^1, & \text{otherwise} \end{cases}. \tag{3}$$

Then, the conditions for an efficient equilibrium, i.e. in which no player contributes more than the value of the project and the threshold is exactly met, are:

(i) $\sum_{i=1}^n g_i^1 + \sum_{i=1}^n g_i^2 = T$ and
(ii) $g_i^1 \leq B$, with $g_i^2 \leq \min\{B - g_i^1, w - g_i^1\}, \forall i$

In the *Sunk* treatment, regardless of the informational condition, the individual first-stage contribution is sunk and, therefore, it does not matter for the contribution decision in the second stage. In this case, player i completes the project in the second stage if the remaining difference to the threshold, given the total contribution of the co-players, does not exceed the value of the project B and satisfies the budget constraint. Hence, player $i's$ best-response function reads:

$$g_i^2(G_{-i}^2) = \begin{cases} T - G^1 - G_{-i}^2, & \text{if } T - G^1 - G_{-i}^2 \leq \min\{B, w - g_i^1\} \\ 0, & \text{otherwise} \end{cases} \tag{4}$$

Thus, the second-stage contribution depends on the first-stage contribution only if the budget constraint binds. If the available funds are sufficient to complete the project, then the player does not take into account the contribution made in the first stage. It follows that the conditions for an efficiency equilibrium in this case are:

(i) $\sum_{i=1}^n g_i^1 + \sum_{i=1}^n g_i^2 = T$ and
(ii) $g_i^1 \leq B$, with $g_i^2 \leq \min\{B, w - g_i^1\}, \forall i$

Comparing (3) with (4) it is easy to see that, for any level of the first-stage contribution, the second-stage upper limit of the best-response contribution of player i is always higher in the *Sunk* treatment than in the *NoSunk* treatment, provided the endowment is sufficiently high, i.e. $w > B$. If $w \leq B$, the two treatments allow for the same level of contributions in the second-stage, given the same level of the first-stage contributions. In sum, ceteris paribus, the upper bound of the best-response contribution is weakly higher in the *Sunk* treatment than in the *NoSunk* treatment.[2]

Because theoretically the players are symmetric, i.e. they have the same endowments, the same value for the public good and the same payoff function, it is worth at this point to mention the symmetric efficient subgame perfect equilibria. These are the equilibria for which the public good is exactly provided and the cost of the public good is shared among the group members, i.e. $g_i^1 + g_i^2 = g_j^1 + g_j^2 = T/n, \forall i \neq j$. There is an infinity of these equilibria and they differ with respect to the profile of the individual contributions over the two stages.

[2] Note that within the same treatment there are no differences with respect to the set of equilibria across informational conditions.

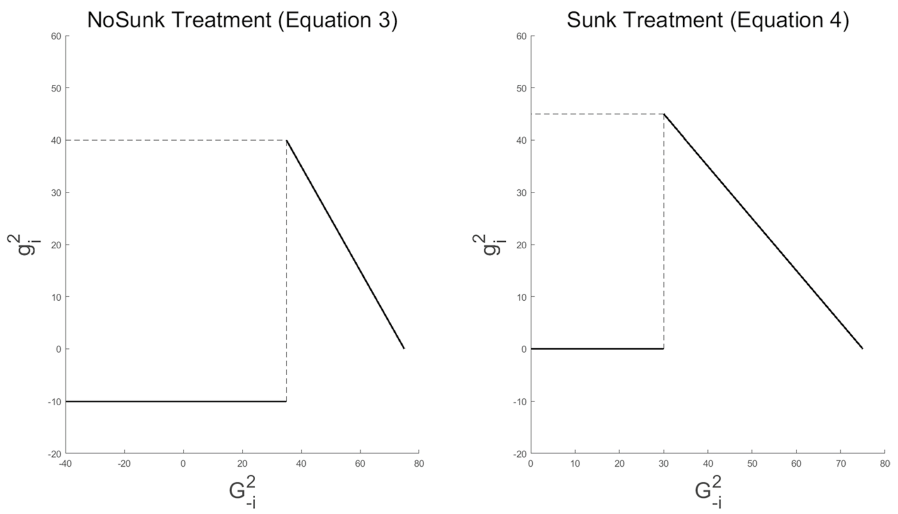

Fig. 1 Second-stage best-response functions for the history of play $g_i^1 = 10$, $G_{-i}^1 = 40$.

The experimental parameters are borrowed from Croson and Marks (2000) are: $n = 5$, $B = 50$, $w = 55$ and $T = 125$. Note that these parameters ensure that the project is feasible, i.e. the total endowment of the players exceeds the threshold $T \leq nw$ and that efficient equilibria exist, i.e. the total benefit from the project exceeds the provision point $nB \geq T$. Note also that $w > B$ such that in an efficient equilibrium the second-stage upper limit of the best-response contribution of player i is strictly higher in the *Sunk* treatment than in the *NoSunk* treatment for the same level of the first-stage contribution.[3] For an illustration, Fig. 1 shows the best-response functions derived in Eqs. (3) and (4) for the above parameters and the history of play $g_i^1 = 10$ and $G_{-i}^1 = 40$.

We are now ready to formulate the experimental hypotheses. As demonstrated by the best-response functions, contributions in the second stage should be larger in the *Sunk* treatment than in the *NoSunk* treatment. However, because the ex-ante information plays a role for the decision of the first stage contributions, the expectation is that they will differ significantly between the two treatments in the *Info* condition, but not in the *NoInfo* condition. Therefore, the following two hypotheses result:

Hypothesis 1 Holding the first-stage individual contributions constant, in the *Info* condition the second-stage individual contributions are larger in the *Sunk* than in the *NoSunk* treatment.

Hypothesis 2 In the *NoInfo* condition, the second-stage individual contributions are larger in the *Sunk* than in the *NoSunk* treatment.

[3] An example of a symmetric subgame perfect efficient equilibrium is in this case $(g_i^1 = 0; g_i^2 = 25), \forall i = 1, \ldots 5$.

If Hypothesis 2 is confirmed, then the rate of project completion should be higher in the *NoInfo-Sunk* treatment than in the *NoInfo-NoSunk* treatment. Note also that, while the payoff structure is the same in the *Sunk* treatment as in the *NoSunk* treatment, the confirmation of Hypotheses 1 and 2 solely depends on subject's rationality regarding sunk contributions, which remains to be observed in the experiment.

3.2 Procedure

The experimental sessions were conducted in a computer laboratory at the University of Kassel, in Germany. The participants were randomly selected from the pool of volunteers recruited from the general student population, with no prior experience of participating in economic experiments. The recruitment software was ORSEE (Greiner 2004) and the experiment was programmed in z-Tree (Fischbacher 2007). No subject took part in more than one session and subjects were randomly assigned to treatments, i.e. a between-subject design was implemented.

After being seated at the computer stations, the instructions were read aloud to ensure common knowledge.[4] The participants were randomly assigned to groups of five which stayed fixed throughout the experiment. The randomization was executed by the experimental software. In a single session was conducted either the *Info-Sunk* treatment, the *Info-NoSunk* treatment or the *NoInfo* condition in which groups were randomly assigned to the *Sunk* and *NoSunk* treatment. Thus, in the *NoInfo* condition the randomization for the two treatments was done at session level.

Each experimental session consisted of two parts. While the introduction informed the participants that the experiment consisted of two parts, they received the instructions for the second part only after the first part was completed. The first part elicited subjects' risk preferences according to Holt and Laury (2002) menu of lottery choices. The risk-preference elicitation task was played for real stakes such that the earnings in this part of the experiment were added to the final earnings of the participants. However, the outcome of the lottery and the earnings from this task were announced to the participants only at the end of the experiment, after the main experimental task was completed. Therefore, this task could not affect the decisions made in the main experimental task.

The second part of the experiment consisted of the main threshold public good game, which was played in one single round. Before the participants played the one-shot threshold public good game, they answered control questions to ensure a good understanding of the rules of the game and to ensure that the participants were aware of the available strategies and their implications. Any questions that occurred during this time were answered privately. After all participants answered the control questions correctly, they tried out the game in four trial rounds played against the computer. The instructions made it clear that in the trial rounds the computer played the role of their co-players, i.e. dummy players. The contributions of the computer playing on behalf of the other four co-players were

[4] The experimental instructions for the *NoInfo-Sunk* and the *NoInfo-NoSunk* treatments are reproduced in Appendix 1 (translation from German). The instructions for the other treatments are very similar and they are available from the author upon request.

the same for all participants, in all treatments and were set before the experiment. In particular, in order to experience all possible scenarios in the game and to understand their pivotal role in reaching the threshold, the four scenarios implemented in the trial rounds involved two rounds with low contributions by the dummy players and two rounds with high contributions by the dummy players. Hence, the choice of the scenarios, with both low and high contributions by the co-players ensures that the trial rounds do not have any influence on the actual behavior of the players in the subsequent one-shot game. However, even if there is suspicion of the trial rounds influencing the subsequent behavior in the game, this influence is the same across all treatments.[5] Only when the trial rounds were completed, did the experiment proceed with the actual game. During the game, contributions and earnings were displayed in Taler and it was common knowledge that the final payments would be calculated by applying an exchange rate of 20 Euro cents per Taler.

Expectations about co-players' contributions were elicited as follows. Before deciding on their first-stage contributions, subjects in all treatments were asked to give their best guess of whether their group would complete the project or not. After submitting their first-stage contributions, but before receiving feedback about the other group members' contributions, the subjects gave their guesses about the average contribution of their co-players in this stage and over the two stages together. After completing their second-stage contribution decisions, the subjects were asked again to give their guesses about the second-stage average contributions of their co-players. In fact, the questions about beliefs came as a surprise immediately after the contribution screen and just before the screen that displayed the group's contribution in each stage. Guesses about the completion of the project were not incentivized. Guesses about others' contributions were incentivized such that, with a tolerance of one Taler, each correct guess was rewarded with 5 Taler. However, earnings and thus the outcome of the beliefs elicitation tasks were only displayed at the end of the experiment, together with the total earnings from the main experimental task and from the risk-preference elicitation task. The reader may be concerned about the risk-preference and beliefs elicitation tasks creating a hedging problem and thus affecting the decisions in the main experiment (see, Blanco et al. 2010). Note that the small stakes of these tasks relative to the stakes of the main experimental task, as well as the very small tolerance range in the belief elicitation task, minimize concerns about hedging incentives.[6]

In total, 240 students took part in the experiment. This means a total of 48 groups distributed as follows: 10 groups in the *Info-Sunk* treatment, 9 groups in the *Info-NoSunk*, 13 in the *NoInfo-Sunk* and 16 in *NoInfo-NoSunk*.[7] At the end of the experiment, the

[5] The contributions of the co-players in the trial rounds where the following: Trial round 1 (low)—Stage 1: 0; 5; 0; 4. Stage 2: 2; 1; 8; 1. Trial round 2 (low)—Stage 1: 2; 3; 4; 1. Stage 2: 1; 2; 2; 4. Trial round 3 (high)—Stage 1: 10; 9; 25; 20. Stage 2: 6; 15; 8; 12. Trial round 4 (high)—-Stage 1: 13; 12; 16; 10. Stage 2: 11; 13; 10; 15.

[6] I am grateful to an anonymous referee for pointing out the hedging problem.

[7] I aimed at 10 groups per treatment. This was not realized due to no-shows in one of the *Info-NoSunk* sessions and to the randomization in the *NoInfo* condition, which was done by the experimental software at session level. For the latter reason I had to run more sessions than planned in order to equalize the sample sizes across the treatments of this condition.

Table 2 Means of observables by treatment

Treatment	Info-NoSunk	Info-Sunk	NoInfo-NoSunk	NoInfo-Sunk	*p* value
N	45	50	80	65	
Male	0.49 (0.075)	0.48 (0.071)	0.55 (0.056)	0.60 (0.061)	0.5408
Age	25.69 (0.675)	26.08 (0.603)	25.61 (0.493)	25.98 (0.492)	0.7440
HL safe choices	5.47 (0.197)	5.28 (0.297)	5.54 (0.173)	5.80 (0.224)	0.6632

Standard errors are reported in parentheses. “HL safe choices” refers to the number of safe choices made in the risk-preference elicitation task, being thus a coarse measure of risk aversion. The *p* values are reported from the Kruskal–Wallis equality-of-populations rank test

participants were paid their earnings privately, in cash. The total earnings over the two parts of the experiment ranged from 3 to 23 Euro with an average of 13 Euro.

4 Results

The results are structured as follows. First I analyze the individual contributions in the two stages of the game separately and then I discuss the group outcome over the two stages. At each stage I use non-parametric and regression analysis, controlling for the expectations about co-players’ contributions and, in the second stage, for co-players’ first-stage contributions.

Before presenting the results, Table 2 shows, for each of the four treatments, the summary statistics with respect to the observable demographic variables collected via the final questionnaire of the experiment, together with the measure of the risk aversion. The last column in the table shows the *p* values of the Kruskal–Wallis equality-of-populations rank test, which tests whether at least two of the four treatment groups differ significantly from each other. As this test shows, there are no significant differences across the treatments with regard to these observables.

In the analysis that follows I will report *p* values from the Wilcoxon rank-sum (Mann–Whitney), unless otherwise specified.

4.1 First-stage behavior

In the analysis of the first-stage behavior, the first-stage contributions in the *NoInfo* condition are pooled together. This can be done for two reasons. First, as shown in Table 2, there are no statistically significant differences in subjects’ observables across the treatment groups. Second, in the first stage of contributions there are no differences in subjects’ experience across the two conditions of this treatment. Thus, the bars in Fig. 2 show the individual mean contributions in the first stage for the two treatments in the *Info* condition and for the *NoInfo* treatment. The errors bars represent the 95% confidence interval of the mean contributions. As this figure shows, the first-stage contributions are significantly lower in the *Info-Sunk* treatment than in the *Info-NoSunk* treatment ($p = 0.000$), reflecting the non-commitment feature of the *NoSunk* treatment.

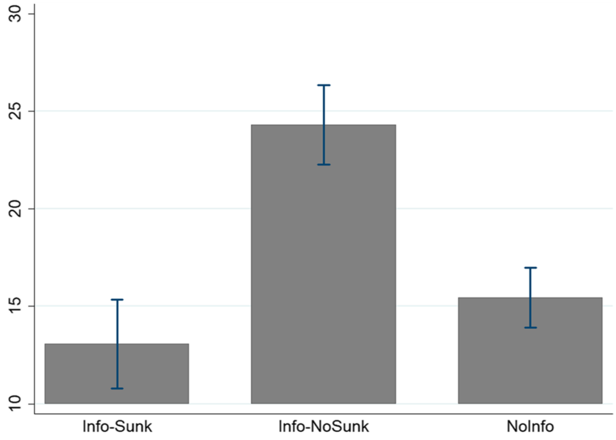

Fig. 2 First-stage mean individual contributions by treatment

Table 3 Individual contributions in Stage 1 (OLS regression)

Dependent variable: Individual Contributions in Stage 1			
	(1)	(2)	(3)
Info-Sunk	− 2.354	− 3.795	− 2.433
	(1.371)*	(1.091)***	(1.099)**
Info-NoSunk	8.877	7.633	5.736
	(1.273)***	(1.457)***	(1.508)***
Guess completion		11.114	6.795
		(1.208)***	(1.651)***
Guess Stage 1			0.444
			(0.114)***
Guess Total			0.184
			(0.080)**
Constant	15.434	7.540	− 0.191
	(0.780)***	(1.078)***	(1.361)
Adjusted R^2	0.16	0.41	0.53
N	240	240	240

Robust standard errors in parentheses. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. "Guess completion" is a dummy variable which shows player's belief of whether her group will reach the thereshold or not. "Guess Stage 1", 'Guess Stage 2" and 'Guess Total" are player's beliefs about the average contribution of her co-players in the first stage, second stage and in total over the two stages, respectively. In all three regressions the reference group is the *NoInfo* treatment, with both of its conditions, *Sunk* and *NoSunk*

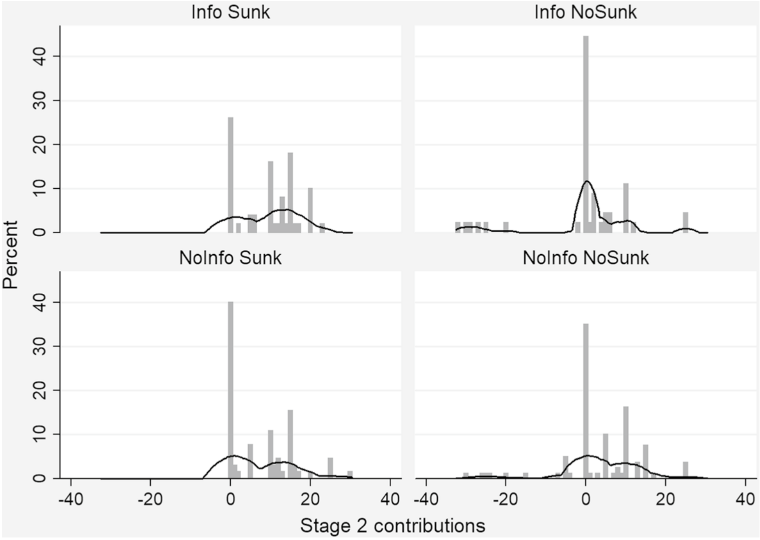

Fig. 3 Distribution of the second-stage individual contributions by treatment

In fact, the first-stage contributions in *Info-NoSunk* are not statistically different from the fair-share of 25 Taler (Wilcoxon signed-rank test $p = 0.571$). This shows that in risk-free conditions, people naturally direct their behavior towards fairness.

The regressions in Table 3 explain the individual first-stage contributions as a function of the treatment conditions, in which the *Sunk* and the *NoSunk* treatments of the *NoInfo* condition are pooled together and form the reference group. As regression (1) of this table shows, the contributions in the *NoInfo* condition, including both the *Sunk* and the *NoSunk* treatment, are larger than in the *Info-Sunk*, but they are significantly smaller than in the *Info-NoSunk* treatment. These results are intuitive and they reflect the first-stage uncertainty of the *NoInfo* condition in which the subjects do not know whether in the second stage their first-stage contributions become sunk or not. Regressions (2) and (3) in Table 3 include further controls. Regression (2) shows that in the reference group, i.e. the *NoInfo* condition, believing that her group will complete the project prompts a player to contribute on average 11 Taler more than a player who does not expect a project completion. This is both economically and statistically significant. Recall that these beliefs were elicited before the player made her first-stage contribution. The last column of the table includes player' beliefs about co-players contributions in the first stage and in total over both stages. The results show that both beliefs affect positively and significantly players' contributions in the first stage. Note that these beliefs were elicited after the first-stage contributions were made, but before the contributions of the co-players were revealed.

Table 4 Treatment effects (OLS regression)

Dependent variable: Individual contributions in stage 2

	Info			NoInfo		
	(1)	(2)	(3)	(4)	(5)	(6)
Sunk	10.080	0.299	0.240	4.400	3.765	3.703
	(2.577)***	(3.487)	(3.426)	(1.870)**	(1.850)*	(1.853)*
mStage 1		− 0.827	− 1.054		− 0.237	− 0.422
		(0.135)***	(0.140)***		(0.109)**	(0.115)***
Sunk × mStage 1			0.347			0.375
			(0.202)			(0.147)**
Others Stage 1		− 0.189	− 0.189		0.032	0.035
		(0.096)*	(0.096)*		(0.065)	(0.065)
Beliefs Stage 2		0.240	0.250		0.437	0.479
		(0.114)**	(0.115)**		(0.137)***	(0.128)***
Constant	− 0.400	16.275	16.233	3.200	− 3.040	− 3.638
	(2.433)	(8.668)*	(8.760)*	(1.390)**	(5.459)	(5.350)
Adjusted R^2	0.202	0.419	0.421	0.045	0.225	0.248
N	95	95	95	145	145	145

Group level clustered robust standard errors in parenthesis. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. "mStage 1" is the difference between player's contribution in the first stage and the mean contribution of her group in that stage; "Sunk" is a dummy for the treatment in which the first-stage contribution is sunk; "Others Stage 1" is the total contribution of the co-players in Stage 1; "Beliefs Stage 2" is player's belief about co-players' average contribution in the second stage. In each informational condition the reference groups are the *NoSunk* treatments

4.2 Second-stage behavior

I now turn to analyzing the second-stage contributions which are the focus of the research hypotheses of this study. The bars in Fig. 3 show the distributions and the smooth lines show the kernel density estimations of the second stage contributions by treatment. As seen in Sect. 4.1, in the *Info-NoSunk* treatment subjects contribute on average their fair-share in the first stage. However, they withdraw some of these contributions in the second stage (see the negative contributions in Fig. 3) such that on average they are lower than the positive contributions in the *Info-Sunk*.

The unconditional treatment effect shown in regression (1) of Table 4 confirms this result, i.e. the subjects in the *Sunk* treatment contributed significantly more in the second stage than the subjects in the *NoSunk* treatment. However, since this test does not condition on the first-stage contributions, it provides only a partial support for Hypothesis 1.

Similarly, regression (4) of Table 4 shows that in the *NoInfo* conditions, the second-stage contributions in the *Sunk* are significantly higher than in the *NoSunk* treatment. This provides support for Hypothesis 2, showing that subjects rationally ignore the sunk contributions made in the first stage.[8] This effect does not seem to be explained by a larger crowding of zero contributions in the *Sunk* treatment, as the lowest possible contribution in this treatment, compared to the *NoSunk* treatment or, in general, by the larger action space of the latter treatment compared to the former. First, as Fig. 3 shows, there are no differences in the frequencies of zero contributions between the *NoInfo-NoSunk* and the *NoInfo-Sunk* treatments (40% in *NoInfo-Sunk* versus 35% in *NoInfo-NoSunk*, $p = 0.5371$). Second, only 15% of the contributions made in the second stage in the *NoInfo-NoSunk* treatment were negative. Third, while the frequencies of strictly positive contributions in the two treatments are not statistically different ($p = 0.2308$), they are higher in the *NoInfo-Sunk* treatment than in *NoInfo-NoSunk* treatment ($p = 0.0586$).

In the remaining regressions of Table 4 I control for the contributions made in the first stage.[9] Furthermore, for the ease of interpretation, the variable for the first-stage contributions (*mStage1*) is centered around the average contribution within each group, i.e. it is expressed as the difference of player *i*'s contribution from the average contributions of his/her group in the first stage, i.e. $g_i^1 - \frac{1}{n}\sum_{j=1}^{n} g_j^1$. In addition, I control for the contributions made by the co-players in the first stage and the beliefs about the average contributions made by the co-players in the second stage. Finally, the specifications in columns (3) and (5) allow for the *Sunk* treatment to vary with the contributions make in the first stage by interacting it with the dummy for the *Sunk* treatment of each informational condition.

Regardless of the specification, the second-stage contributions in the *NoSunk* treatments are decreasing in the first-stage contributions in both informational conditions (see the coefficient of *mStage1*), albeit at a lower rate in the *NoInfo* condition. Specifically, the more a player contributed above her group's average in the first stage, the less she contributed in the second stage. This is explained by the fact that due to the non-sunk character of the first-stage contributions, the contributions in this treatment are essentially made in one stage (static game). Therefore, higher contributions in the first stage bring lower contributions in the second stage and vice-versa.

The effect of controlling for the first-stage contributions is that for both informational conditions the magnitude of the unconditional treatment effect diminishes, and significantly so for the *Info* condition for which it also becomes statistically insignificant. For the *NoInfo* condition, however, the drop in magnitude is negligible and the coefficient remains statistically significant. Specifically, subjects that contributed close to the group's average contribution in the first stage, contributed on average about 4 Taler more in the second stage if they were in the *Sunk* treatment as compared to those in the *NoSunk* treatment.

8 To see this, compare the best-response functions in Eqs. (3) and (4) to note that, on the positive branch, the contributions in the *Sunk* treatment have a higher upper bound than in the *NoSunk* treatment, exactly due to their independence of the first-stage contribution g_i^1.

9 As the scatter plots in Fig. 6 suggest, the relationship between the first- and the second-stage contributions is linear.

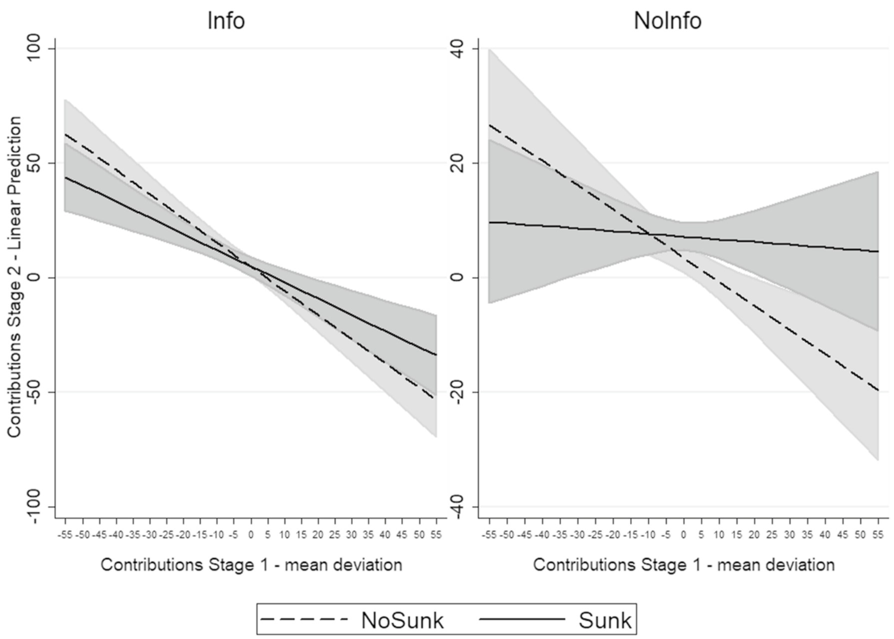

Fig. 4 Linear predictions of second-stage contributions

Moreover, as the interaction terms in columns (3) and (6) show, the difference between the *Sunk* and the *NoSunk* treatments increases the further away we move above the group's mean first-stage contribution, but this is statistically significant only for the *NoInfo* condition. Moreover, the difference between the two treatments is larger in the *NoInfo* condition than in the *Info* condition.[10] This means that, ceteris paribus, the more a player contributed in the first stage, the larger is her second-stage contribution in the *Sunk* treatment compared to the *NoSunk* treatment. To visualize these effects, Fig. 4 shows the linear predictions of the second-stage contributions as a function of the deviations of the first-stage contributions from their mean, at the average values of the co-variates.[11] At all levels of the first-stage contributions that are above the average group's contribution, the contributions in the *Sunk* treatment are higher than in the *NoSunk* treatment. This can be interpreted as high contributors, i.e. those who contribute over the group's average, having a rational

[10] In fact, as the regression in column (2) of Tables 5 in Appendix 2 shows, the treatment effect in the *NoInfo* condition increases significantly relative to the *Info* condition, the further away we move above the group's mean first-stage contribution. This is given by statistically significant negative coefficient of the interaction term between the informational condition, the treatment dummy and the distance from the group's mean first-stage contribution.

[11] The figure is based on the models with interaction terms in columns (2) and (4), since these models provided the highest explanatory power according to the adjusted R^2. The shaded areas represent the 95% confidence intervals of the linear predictions. For each condition, the dark-gray area pertains to the *Sunk* treatment, while the light-gray area refers to the *NoSunk* treatment.

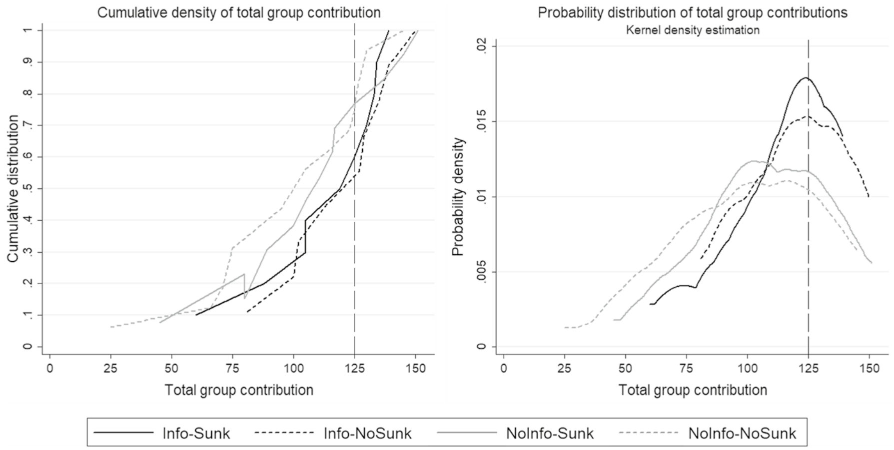

Fig. 5 Distribution of total group contributions

behavior towards completing the project after learning that the first-stage contributions are irreversible. This finding indicates that the reaction of the contributors who withdraw their contributions in final stages in response to the behavior of free-riders is not the only explanation for the differences between a setting with revocable and one with irrevocable contributions as in Goren et al. (2004). Instead, the individual response of the contributors to their own previous sunk contributions adds to this explanation.

Remarkably, in the *NoInfo* condition, the contributions made by the co-players in the first stage fail to predict the contributions made by a player in the second stage, i.e. the coefficients on *Others Stage 1* are not statistically significant and are economically null. These coefficients are negative, but only marginally significant in the *Info* condition indicating a tendency to free-ride on the co-players that signal to be high contributors through their first-stage behavior. This is unlike the evidence reported by Duffy et al. (2007) who, in a setting with complete information and irreversible contributions, found that players respond positively to previous positive contributions of their co-players. What seems to matter more, however, is the expectations about the co-players' contributions in the second stage. This increases significantly one's contribution in the second stage and this effect is stronger, both economically and statistically, in the *NoInfo* than in the *Info* condition.[12]

[12] Although the subjects face uncertainty about the second-stage options, individual first-stage contributions in the *NoInfo* condition were not found to correlate with the measure of the risk aversion used in this paper ($corr = -0.1411$, $p = 0.0904$). Moreover, the number of safe choices in the risk-preference elicitation task where not statistically significant in any of the specifications presented in Table 4 and, therefore, omitted.

4.3 Group outcome

At group level, the first-stage contributions in the *NoSunk* treatment are significantly higher than in the *Sunk* treatment, for each of the two informational conditions ($p = 0.0351$ for *NoInfo* and $p = 0.0002$ for *Info*). While in the *Info* condition, this difference may be explained by the perfect knowledge regarding the second-stage options, there is no explanation for why this difference exists in the *NoInfo* condition. The direction of the comparisons is reversed for the second-stage contributions such that they are lower in the *NoSunk* treatment than in the *Sunk* treatment ($p = 0.0392$ for *NoInfo* and $p = 0.0006$ for *Info*). As a result, there are no statistically significant differences in the total group contributions over the two stages between the *Sunk* and the *NoSunk* treatments for either of the two informational conditions. In fact, only 40% of all groups reached total group contributions of 125 or higher, i.e. completed or over-completed the project. In the *NoInfo-Sunk* treatment 50% of the groups completed the project, while in the *Info-NoSunk* treatment 55% of the groups reached the provision threshold. This share amounts to 31% in both treatments of the *NoInfo* condition.

This can be grasped from Fig. 5 in which the left picture shows the cumulative distribution and the right picture shows the estimated probability distribution of the total group contributions for each treatment. In both pictures the vertical dashed line shows the provision point of 125 Taler. The black lines correspond to the *Info* condition and the gray lines correspond to the *NoInfo* condition. In both informational conditions the continuous lines show the probability distribution for the *Sunk* treatment and the dashed lines show the same for the *NoSunk* treatment.

Remarkable from Fig. 5 is the change in the steepness of the cumulative density functions around the level of 100 Taler of contribution, indicating that most groups reached at least this contribution level. Indeed, the majority of the groups, i.e. 71%, reached total contributions of at least 100 Taler. This is a special contribution point because it means that, on average, one out of the five group members did not contribute her fair share of 25 Taler, leading to a miscoordination problem. This type of miscoordination seems to have been more sever in the *NoInfo* condition as confirmed by the peak of the probability distributions around the 100 Taler contribution point.[13] Although these distributions are not statistically different from each other, neither within nor across the informational conditions, the *Sunk* treatments of each condition exhibit higher frequencies in the regions of high contributions than do the respective *NoSunk* treatments, i.e. in the region of 100 Taler in the *NoInfo* condition and 125 Taler in the *Info* condition.[14] This result is an indication of the fact that making contributions sunk from one stage to another can improve the overall

[13] Figure 7 in Appendix 2 provides more detail on groups' performance by graphing the total individual contribution of each player over the two stages, for each group and treatment. Thus, this figure offers a detailed overview of the mis-coordination problem in each group.

[14] In the *NoInfo* condition 69% of the groups reached 100 Taler in the *Sunk* treatment and 56% of the groups reached this level in the *NoSunk* treatment.

provision of the good, though the current experiment fails to find a statistically significant effect of sunk contributions on total group contributions.

5 Discussion and conclusion

This paper investigated players' responses to own past contributions in a threshold public-good game in which contributions are spread over two stages, i.e. a dynamic contribution setting. Unconditional tests show that previously-sunk contributions induce higher subsequent contributions, even when it is known in advance of the first-stage contributions that they will become sunk in the second stage. Furthermore, players for which past contributions are sunk contribute subsequently more to the public good than those whose past contributions are not sunk, and this is more so the higher their past contributions. In the two-stage contribution game used in this paper, this difference is larger for those players who do not know ex-ante whether their first-stage contributions become sunk or not in the second stage.

Note that in Duffy et al. (2007), Goren et al. (2003, 2004) and Dorsey (1992) players know in advance of the first contribution stage whether their past contributions become sunk or not in the second stage. This means that in these papers only the *Info* treatment is implemented. Another important difference with the previous studies is that in the experiment reported here there were only two opportunities to give, while in the previous studies there are multiple such opportunities. In only two opportunities to give, players have also fewer opportunities to test others' willingness to give. Therefore, when the first-stage contributions are not sunk and this is known ex-ante, subjects in this experiment test the trustworthiness of their co-players "all the way", i.e. on average, they make the fair-share contribution right in the first stage. This creates a significant gap in the first-stage contributions between the two sunk conditions of the full-information treatment.

This study failed to find that the total group contributions in the dynamic setting with sunk past contributions are higher than the contributions made in a dynamic setting that is theoretically equivalent to a static one, i.e. in which past contributions are not sunk. This finding is in line with Duffy et al. (2007) in which the contributions made in a dynamic game that is theoretically equivalent to a static game are no different from those made in a pure dynamic game. However, the purpose of the current study was not to show that sunk contributions lead to overall higher group contributions. Instead, the experiment was set to show that the individual responses to own sunk contributions may explain the better performance of the dynamic play, in which past contributions are sunk, as compared to the static play, in which there is no opportunity to sink contributions. Moreover, as already mentioned, the experiment reported here had only two opportunities to give. If each opportunity makes it more likely for players to fructify their next opportunity to give, then more rounds of contributions would bring about higher completion rates. Indeed, Choi et al. (2008) find that extending the horizon of contributions improves the provision rates, and significantly so the higher the provision threshold. Additionally, increased overall contributions could also result from providing inter-stage feedback only about the total group contributions, as in Duffy et al. (2007), and not about individual contributions. This may have the effect of focusing players' attention on the group's goal and minimizing anti-social reactions to individual free-riders.

Finally, the low performance at group level across all treatments and conditions is likely due to player' failure to coordinate on one of the multiple completion equilibria. While repeated play would have provided information on how players learn to coordinate, this endeavor was out of the scope of this paper. Since, the response to sunk contributions is an individual behavior, this study was concerned with understanding the individual response to own past contributions and not on how players coordinate in a social context. Therefore, one round of play provides the crudest form of this response, unaltered by a learning effect. While, these are all interesting avenues for understating the effect of individual biases on social outcomes, I leave them for future research.

Appendix 1: Experimental instruction

These are the experimental instructions for the *NoInfo* treatment (translated from the German language). The instructions for *Info-Sunk* and *Info-NoSunk* are very similar.

Welcome to the experiment and thank you for your participation!

General instructions

In this experiment you can earn money. Your payment will be determined by the course of the game, which means that it depends on your own decisions and on the decisions of your co-players. Now carefully read the following rules of the game. If you have questions, please raise your hand. We will come to you and answer your questions.

All decisions in this experiment are anonymous. For the payment of your earnings you will have to sign a receipt. The receipts are needed only for billing and accounting. However, under no circumstance will we connect your names with the decisions in the experiment. <u>Important rules:</u>

1. From our side: NO DECEPTION. We promise that this experiment will be conducted exactly as described in these instructions. This is the rule for all experiments that are conducted in K-Lab. We can publish our results only when we follow this rule consistently and under all circumstances.
2. From your side: NO COMMUNICATION. Please do not communicate with other participants during the experiment and take your decisions individually. Your mobile phones and other communication devices must be switched off during the entire experiment. The experiment will run at computers. You are only allowed to use those features of the computer that are needed for the course of the experiment. Communication with other participants, the use of mobile phones and the use of other functions of the computer than those required for the experiment lead to exclusion from the experiment and the loss of all earnings.

Part 1

The experiment consists of two parts. These are the instructions for Part 1. You will receive the instructions for Part 2 as soon as Part 1 is concluded. The two parts of the experiment are independent from each other. Your earning from both parts will be paid to you in cash right at the end of the experiment. The payment will made in private such that no other participant can see how much you have earned. After the experiment you will be asked to answer a short questionnaire.

Your earnings in Part 1 depend only on your individual decisions. The decision table below shows ten decisions. Every decision is a choice between "Option A" and "Option B". You will make the ten decisions at the computer and document them by clicking either on "Option A" or on "Option B". Before you made the ten decisions, please take a look at how exactly these decisions influence your earnings.

Decision	Option A	Option B
1	With 1/10 Probability: 2.00 Euro;	With 1/10 Probability: 3.85 Euro;
	With 9/10 Probability: 1.60 Euro	With 9/10 Probability: 0.10 Euro
2	With 2/10 Probability: 2.00 Euro;	With 2/10 Probability: 3.85 Euro;
	With 8/10 Probability: 1.60 Euro	With 8/10 Probability: 0.10 Euro
3	With 3/10 Probability: 2.00 Euro;	With 3/10 Probability: 3.85 Euro;
	With 7/10 Probability: 1.60 Euro	With 7/10 Probability: 0.10 Euro
4	With 4/10 Probability: 2.00 Euro;	With 4/10 Probability: 3.85 Euro;
	With 6/10 Probability: 1.60 Euro	With 6/10 Probability: 0.10 Euro
5	With 5/10 Probability: 2.00 Euro;	With 5/10 Probability: 3.85 Euro;
	With 5/10 Probability: 1.60 Euro	With 5/10 Probability: 0.10 Euro
6	With 6/10 Probability: 2.00 Euro;	With 6/10 Probability: 3.85 Euro;
	With 4/10 Probability: 1.60 Euro	With 4/10 Probability: 0.10 Euro
7	With 7/10 Probability: 2.00 Euro;	With 7/10 Probability: 3.85 Euro;
	With 3/10 Probability: 1.60 Euro	With 3/10 Probability: 0.10 Euro
8	With 8/10 Probability: 2.00 Euro;	With 8/10 Probability: 3.85 Euro;
	With 2/10 Probability: 1.60 Euro	With 2/10 Probability: 0.10 Euro
9	With 9/10 Probability: 2.00 Euro;	With 9/10 Probability: 3.85 Euro;
	With 1/10 Probability: 1.60 Euro	With 1/10 Probability: 0.10 Euro
10	With 10/10 Probability: 2.00 Euro;	With 10/10 Probability: 3.85 Euro;
	With 0/10 Probability: 1.60 Euro	With 0/10 Probability: 0.10 Euro

At the end of the experiment the computer will randomly generate two numbers between 1 and 10. The first number determines which of the ten decisions will be used for payment. The second number determines the earnings from the option you chose: A or B. That means that although you make ten decisions, only one will be used for payment. Every single decision has the same chance of being drawn. Since you do not know in advance which decision will be drawn, you should make every decision as if it determines your payment.

Please look at decision 1 in the table. Option A provides a gain of 2.00 Euro if the random number is 1 and a gain of 1.60 Euro if the random number is 2–10. Option B provides a gain of 3.85 Euro if the random number is 1 and a gain of 0.10 Euro if the random number is 2–10. The other decisions are similar, whereby the chances for a higher gain rises as you go further down in the table. For the decision number 10 in the last raw of the table the second random number is not needed since the probability for the highest gain is one. Thus, the decision is between 2.00 Euro in Option A and 3.85 Euro in Option B.

In summary, you will make ten decisions of which only one will be used for payment at the end. For each decision in the table, you must choose between Option A and Option B. When you are done, click "Next".

You will learn the two computer generated random numbers and your gain in Part 1 only after completing Part 2.

Part 2

In Part 2 you are a member of a group of **five players**. That means that apart from you there are four other players in your group. Each player faces exactly the same decision problem. Each player receives 55 Taler. You will see these Taler in your **private account** displayed on the top-right corner of your computer screen. In the game, you will decide whether you want to contribute your Taler to a **common project**. It is possible to contribute any integer amount from 0 to 55 Taler. The Taler that you do not contribute to the common project remain in your private account.

If the group contributes in total **125 Taler or more** to the common project, then every player in the group receives a **bonus of 50 Taler**. This bonus is then added to the Taler remaining in the private account, regardless of how much a player contributed to the common project. Your profit in this case is:

$$\textit{Your profit} = \textit{Remaining Taler in private account} + \mathbf{50}\ \textit{Taler}$$

If the group contributes in total **124 Taler or less** to the common project, then there is no bonus. Your profit in this case is:

$$\textit{Your profit} = \textit{Remaining Taler in private account}$$

Below we describe a few numerical examples.

Example 1: Suppose that the other four players in your group contribute in total 80 Taler to the common project. If you contribute 10 Taler, your payoff is 45 Taler (= 55 − 10). If you contribute 25 Taler your payoff is 30 Taler (= 55 − 25). If you contribute 45 Taler your payoff is 60 Taler (= 55 − 45 + 50).

Example 2: Suppose that the other four players in your group contribute in total 100 Taler to the common project. If you contribute 10 Taler, your payoff is 45 Taler (= 55 − 10). If you contribute 25 Taler your payoff is 80 Taler (= 55 − 25 + 50). If you contribute 45 Taler your payoff is 60 Taler (= 55 − 45 + 50).

Example 3: Suppose that the other four players in your group contribute in total 120 Taler to the common project. If you contribute 10 Taler, your payoff is 95 Taler (= 55 − 10 + 50). If you contribute 25 Taler your payoff is 80 Taler (= 55 − 25 + 50). If you contribute 45 Taler your payoff is 60 Taler (= 55 − 45 + 50).

Please notice the following important rules of the game. The game will be played over **two stages**. Your contribution to the common project is **the sum** of your contribution in Stage 1 and your contribution in Stage 2. If, for example, you contribute 5 Taler in Stage 1 and 10 Taler in Stage 2, then your contribution to the common project is 15 Taler.

In Stage 1 you can contribute to the common project any integer amount from 0 to 55 Taler. After all players have chosen their contributions in Stage 1, the individual contributions of all players in Stage 1 as well as the sum of all contributions in Stage 1 will be shown on the computer screen. The own contribution for each player will be shown in boldface.

In Stage 2 there are two options. The computer decides randomly which of the two options realizes for your group, while each option has equal chance. In Option 1 it is only possible that you leave the current contribution unchanged or you contribute more Taler to the common project. In Option 2 it is possible that you leave the current contribution unchanged, that you contribute more Taler to the common project or that you withdraw from your contribution make in Stage 1. If you want to contribute more Taler, any contribution from 0 to the remaining funds in your private account is possible. You will see the funds remaining in your private account displayed in the upper-right corner of the computer screen. If you want to withdraw (and this is possible) from the contribution made in Stage 1, you must enter a negative value as your contribution in Stage 2. For example, if you want to withdraw 5 Taler, then you must enter – 5 in the entry field. You can only withdraw maximum as many Taler as you contributed in Stage 1. The withdrawn Taler will be added back to your private account.

On the computer screen it will be shown which of the two options in Stage 2 is realized for your group. Please note that in Stage 1 you do not know yet which of the two options will be realized. You will only learns this at the beginning of Stage 2. The realization of the option is valid for the whole group. This means that either all players in your group can withdraw the previously made contributions or nobody in your group can do this.

After all players have made their contributions in Stage 2, the individual contributions of all players in both stages as well as the sum of all contributions in both stages are displayed on the screen. The own contribution will be shown in boldface for each player. Note that the group as a whole must contribute at least 125 Taler to the common project over both stages such that the bonus is realized for all players.

The Taler earned in the experiment will be converted in Euro. You will receive 1 Euro for every 5 Taler (0.20 Euro per Taler). If, for example, you earn in total 60 Taler, then you receive 12 Euro.

Before the game in Part 2 begins, we would like to ask you to answer a few control questions at the computer. This way we can make sure that all participants have understood the rules of the game. If you have questions, please raise your hand. We come to you and answer the questions.

After answering the control questions, there will be **four trial rounds**, in which you can try out the game. The trial rounds are **not** relevant for your payment. Please note that in these trial rounds your four co-players will be played by the computer. Therefore, you cannot draw **any** conclusions about the behavior of your future co-players.

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Appendix 2

See Table 5 and Figs. 6, 7.

Table 5 The difference in the treatment effects across the informational conditions (OLS difference-in-differences regression)

Dependent variable: individual contributions in Stage 2		
	(1)	(2)
Info	– 0.225	– 0.182
	(2.023)	(2.042)
Sunk	2.742	2.689
	(1.938)	(1.941)
Info × Sunk	1.730	1.667
	(2.540)	(2.549)
mStage 1	– 0.446	– 0.599
	(0.105)***	(0.109)***
Sunk × mStage 1		0.412
		(0.141)***
Info × Sunk × mStage 1		– 0.419
		(0.154)***
Others Stage 1	– 0.086	– 0.084
	(0.069)	(0.070)
Beliefs Stage 2	0.329	0.356
	(0.094)***	(0.092)***
Constant	5.811	5.524
	(5.362)	(5.394)
Adjusted R^2	0.273	0.290
N	240	240

Group level clustered robust standard errors in parenthesis. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. "mStage 1" is the difference between player's contribution in the first stage and the mean contribution of her group in that stage; "Sunk" is a dummy for the treatment in which the first-stage contribution is sunk; "Info" is the dummy for the condition in which the subjects know in advance of the firs-stage contributions if these becomes sunk or not in the second stage; "Others Stage 1" is the total contribution of the co-players in Stage 1; "Beliefs Stage 2" is player's belief about co-players' average contribution in the second stage

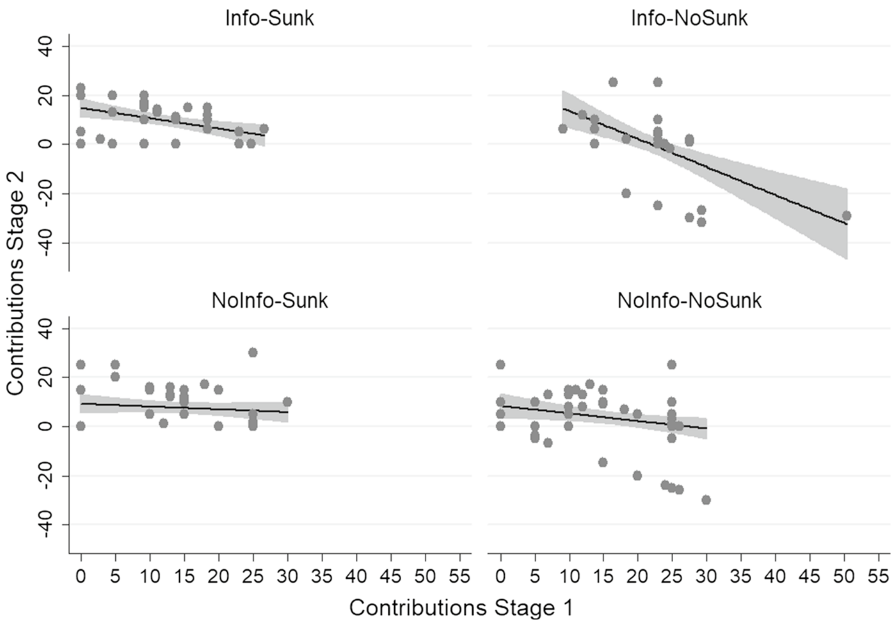

Fig. 6 Relationship between the first- and the second-stage contributions

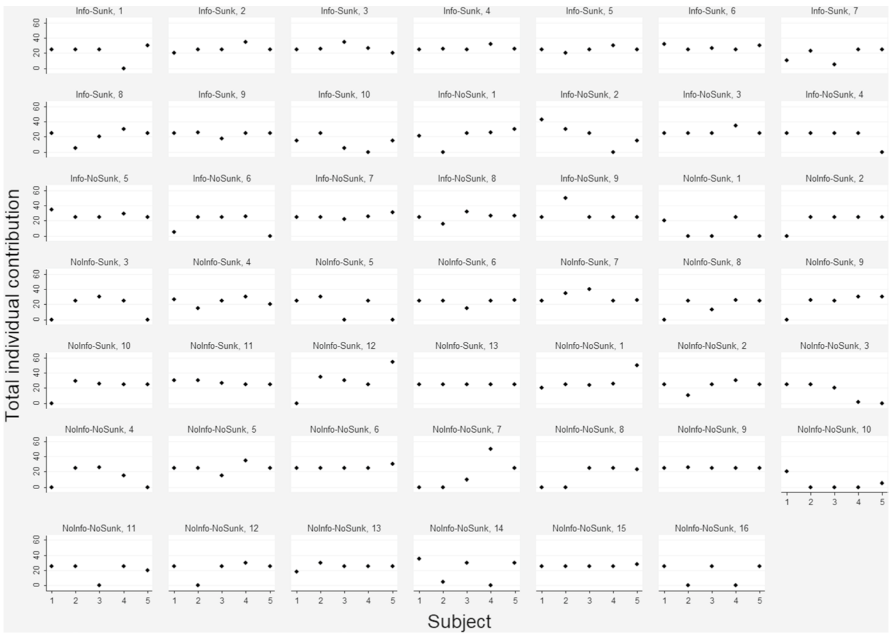

Fig. 7 Individual contributions by group

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