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Behavioral spillovers from freeriding in multilevel interactions

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A B S T R A C T

We study multilevel interactions using experimental methods. Does the efficiency of a production team suffer from the freeriding behavior of some team members at the firm level? Can we identify behavioral spillovers affecting teams? We isolate common tasks that teams must complete – coordination and cooperation – and model each of them using a simple experimental game that is designed to avoid identification problems. By observing a team's efficiency before and after the firm-level event, we identify the behavioral spillovers of freeriding to team-level cooperation and coordination. We demonstrate that team composition with respect to freeriding behavior of individual members during the firm-level conflict conditions behavioral spillovers. In particular, the efficiency of heterogeneous teams decreases after a firm-level conflict, whereas homogeneous teams can improve their performance.

1. Introduction

This study reports on multilevel interactions in organizations. Firms have hierarchical structures, and although most workplace interactions take place among co-workers at the same level, such as within the same team, department or subsidiary, numerous important interactions run *across* organization levels. Examples include firm-level processes, such as establishing a new management structure, implementing innovations, or wage negotiations. Workers' interactions with team members are potentially affected by interactions and conflicts with the same individuals within processes that concern matters at the firm-wide level. Although such multi-level interactions are quite common, our understanding of how interactions at one level impact behavior at another level remains underdeveloped.

Many interactions between employees and management at the firm level – such as conflicts over organizational and strategic changes or over employment conditions – potentially affect team-level interactions. Recently, there has been a call to include the interplay of different levels of interaction in economic and social research to identify the behavioral spillovers running across them (e.g., Hitt et al., 2007; Korsgaard et al., 2008). There is some evidence that positive experiences spill over from one level to another, and cooperation at one level of interaction increases the efficiency of a team operating at another level (Cason, Savikhin, and Sheremeta, 2012). However, positive spillovers only represent one-half of the phenomenon. In this paper, we address the companion question: How do cooperation problems, specifically freeriding at the firm level, spill over from the firm level to team-level interaction? Importantly, firm-level conflict that negatively affects the coordination and cooperation in production teams might ultimately endanger firms' profitability.

The specific question we address is: what are the behavioral spillovers from a firm-level event on a team's (i) coordination and (ii) cooperation in achieving an efficient outcome? In our study, the firm-level event is a social dilemma, in which individual incentives conflict with the interests of the group of workers at the firm level.

Examples of such firm-level events are conflicts over organizational or strategic changes or labor conflicts between management and workers. In all of these cases, the workforce frequently does not act in concert; instead, different opinions might divide the workforce and teams with potential consequences for teamwork and the overall productivity of the firm. Getman and Marshall (1993) observe an escalation of inter-personal conflicts at the team level after a firm-level labor strike, in which certain team members participated and others continued working. A striker is quoted as follows: "I absolutely refuse to give any intelligence. There's all kinds of tricks of the trade that you learn, and when I'm working with a scab [a non-striker], I will not use anything I ever learned. [. . .] I pull my ass eight hours knowing full

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well in five minutes I could get it done another way." (Quote from a striker in Getman and Marshall, 1993: 1841).

Such negative consequences of a strike, as a firm-level conflict, are frequently reported to spill over to work teams. Teams' efficiency decreases due to the fault lines arising after a strike, separating work team members by their behavior during the firm-level event (MacDowell, 1993). Numerous studies report physical, verbal, and social harassment in teams divided by such fault lines (Brunsden and Hill, 2009; Francis, 1985; Barling and Milligan, 1987; Waddington, Dicks, and Critcher, 1994), leading to decreased productivity (Francis, 1985; Getman, 1999; Waddington, Dicks, and Critcher, 1994; Krueger and Mas, 2004; Mas, 2008; Addison and Teixeira, 2009).

Although these behavioral spillovers in multi-level interactions appear to be repeatedly observed in case studies, the mechanism underlying them and their generalizability across work environments remains vague due to missing, incomplete, or limited data. We therefore implement an incentivized experiment, with the goal of identifying behavioral spillovers and isolate their impact on the two main aspects of teamwork: cooperation and coordination. The experimental method allows us to address causality by comparing pre- and post-firm-level conflict situations in teams, as well as the spillover's impact across teams, when production resembles a coordination (weakest link) task and when it resembles a cooperation (public good) task.

2. Theory and experiment design

Team production takes place when a team's output depends on individual efforts, as well as on the externalities they exert (Batt, 2004). In teams, the individual team member's efforts become aggregated into a team outcome, for which the team members receive remuneration. Depending on the nature of the technology generating the output, teams face either of two main challenges, namely *coordination* and *cooperation* (Alchian and Demsetz, 1973; Orr, 2001; Siemsen, Balasubramanian, and Roth, 2007).

Coordination is defined as a situation in which every team member gains by choosing the same action as the other team members, and *cooperation* is a situation in which each team member's individual efforts generate an additional positive externality at the team level (Cassar, 2007: 211). Cooperation differs from coordination in that it entails a tension between the team's interest and self-interest. When in need of coordination, team members agree on what effort will generate the best outcome for the team and for themselves, but when required to cooperate, freeriding is imminent: each team member faces incentives to deviate from the effort that would maximize team production. Let us describe the games that we employed in our experiments to model coordination and cooperation.

First, we model team *coordination* in our experiments using the *weak-link game* (Van Huyck, Battalio, and Beil, 1990; Battalio, Samuelson, and van Huyck, 2001; Knez and Camerer 2000, 2006; Knez and Simester 2001; Dugar, 2010). Accordingly, the experimental treatment implementing this game is referred to as the WL treatment. The weakest link game is a pure coordination game with seven strict Nash equilibria, which can be Pareto ranked. In the experiment, a session always consisted of 12 subjects, who were matched into teams of three and interacted repeatedly on the same team. In the weak-link game, the subjects' payoff was determined by the payoff function:

$$60 + 20^{*} \text{ the "minimum effort in the team"} - 10^{*} \text{ "own effort".}$$

Individual effort was an integer between 1 and 7. Table 1 contains the payoff table for this game.

In this weak-link game, any symmetric strategy profile represents a Nash equilibrium, but efficiency is only obtained if all subjects on a team choose the highest effort of 7. Past research demonstrated that the task of coordinating on the most efficient Nash equilibrium in the weak-link game can be a daunting task (for a review, see Camerer, 2003). Strategic uncertainty prevailing among players explains the lack of immediate coordination on the most efficient equilibrium.

Table 1
Payoffs in the weak-link game.

The payoff table (payoff in points)							
Your final	The lowest final effort in the team						
effort	7	6	5	4	3	2	1
7	130	110	90	70	50	30	10
6	–	120	100	80	60	40	20
5	–	–	110	90	70	50	30
4	–	–	–	100	80	60	40
3	–	–	–	–	90	70	50
2	–	–	–	–	–	80	60
1	–	–	–	–	–	–	70

Table 2
Payoffs in the public goods game.

The payoff table (payoff in points)													
Your final	Sum of efforts of your team members												
effort	14	13	12	11	10	9	8	7	6	5	4	3	2
7	130	123	117	110	103	97	90	83	77	70	63	57	50
6	133	127	120	113	107	100	93	87	80	73	67	60	53
5	137	130	123	117	110	103	97	90	83	77	70	63	57
4	140	133	127	120	113	107	100	93	87	80	73	67	60
3	143	137	130	123	117	110	103	97	90	83	77	70	63
2	147	140	133	127	120	113	107	100	93	87	80	73	67
1	150	143	137	130	123	117	110	103	97	90	83	77	70

Second, we model team *cooperation* using the *linear public goods game* (Ledyard, 1995; Zelmer, 2003). Accordingly, the experimental treatment implementing this game is referred to as the PG treatment. The incentive structure of the game is such that the efficient outcome is not a Nash equilibrium. Although the efficient outcome is better for all players, from the team perspective, it is instable due to the individual incentives to free ride. This game embodies a tension between the individual- and team-level incentives. In the experiment, subjects were also matched into teams of three members and interacted repeatedly on the same team. They had to choose a level of effort, being an integer between 1 and 7, with 1 corresponding to the individually rational action and 7 corresponding to the efficient action. The payoffs are calculated by the payoff function:

$$60 + (20/3)^{*} \text{ "sum of all efforts in the team"} - 10^{*} \text{ "own effort".}$$

Table 2 presents the resulting payoffs.

We parameterized the payoff functions of the two games such that they are easily comparable. The highest and the lowest payoff that the team members can obtain in a symmetric strategy profile are equal in both games. However, the stability of these symmetric strategy profiles varies between games. In the weak-link game, the efficient outcome, with all subjects choosing 7, is a strict Nash equilibrium, but this choice is not an equilibrium due to freeriding incentives in the public goods game. Moreover, the symmetric profile yielding the lowest payoff, with all subjects choosing 1, is a strict Nash equilibrium in both games. Consequently, the willingness of team members to cooperate and their beliefs concerning their teammates being cooperative will affect the possibility of obtaining the efficient outcome for the team in the public goods game. In contrast, coordination in the weak-link game is in the self-interest of each team member, and the team's success solely depends on each member's assessment of the expected behavior of other team members but not on their willingness to cooperate.

In each of the games, the actual choice of the efforts that determined the payoffs was organized as follows: subjects received 2 min time for each interaction, during which they could submit as many effort suggestions as they wished (Deck and Nikiforakis, 2012). After the 2 min, the final effort suggestion was the actual effort and determined the payoffs. Using this "cheap talk" type of environment mimics the coordination processes by which teams arrive at their outcomes to some extent but without compromising the team members' anonymity and without introducing unnecessary structure into the communication among team members (Charness, 2000; Duffy and Feltovich, 2002, 2006) and is characteristic of natural team environments (Feri, Irlenbusch, and Sutter, 2010).

In the context of ongoing teamwork, the team members learn about the effort the others allocate to the team task by observing their own payoff, which is affected by team members' effort. After an initial period of trial and error, stable patterns of behavior on the team will appear (see, for a review, e.g., Ostrom, Walker, and Gardner, 1992). However, we propose that the teamwork is affected by higher-level interactions that cross the boundaries of the team. We study whether a disruption of team production by a higher-level conflict generates behavioral spillovers identified as a difference between team outcomes in the pre- and post-firm-level interaction.

To be specific, the higher-level interaction taking place in our experiments is a session-wide, step-level public goods game in which all individuals in a session, coming from four different teams ($N = 12$), were asked to make a binary choice on whether to 'contribute their participation fee of 3 Euro'. If at least four individuals in a session cooperated and chose to contribute their participation fees, a session-wide public good was produced, and everyone in the laboratory earned an additional amount of 6 Euro. The fixed costs of providing the session-wide public good – 12 Euro – were divided equally only among those choosing to contribute their participation fees. Therefore, the more participants that made this decision, the lower the individual costs of providing the session-wide public good. Moreover, to create the good, it was sufficient if at least four participants made this decision. If fewer than four individuals chose to contribute their participation fees, the session-wide public good was not provided, while the participants contributing their fees still lost the 3 Euro. The decision in this session-wide public goods game thus can be interpreted as a signal of one's willingness to cooperate. To place the payoffs in the session-wide public goods game into perspective, note that the exchange rate used in the weak-link and the public goods game stipulated that 100 points were worth 1 Euro.

In the experiment, subjects were informed that a session consists of three tasks (e.g., Bó, Foster, and Putterman, 2010), but they only received instructions each time for the upcoming task. At the beginning of a session, subjects were randomly assigned to teams of three. In Task 1 (rounds 1–5), they participated in the team production game. In the WL treatment, this was incentivized as the weak link game, and in the PG treatment, it was incentivized as the public goods game. In Task 2 (round 6), the firm-level event was introduced in the form of a session-wide, step-level public goods game that was played once among all 12 subjects in a session, with the members of the four teams present in one session. Thereafter, the teams continued to Task 3 (rounds 7–11), and their teamwork was incentivized by the same payoff function as in rounds 1–5. Using this setup allows us to identify whether the unexpected (session-wide) firm-level event has an impact on the Task 3 production of a specific team, compared to the Task 1 production of the same team. Fig. 1 summarizes the structure of the experiment.

Team members learned of each team member's decision in the session-wide public goods game in Task 2 at the restart of the team production (before round 7). Moreover, the feedback concerning the outcome of Task 2, i.e., whether the session-wide public good was provided, was postponed until the end of the experiment such that only the team member composition with respect to the actions, but not with respect to their consequences, could affect the behavior in Task 3 – if at all.

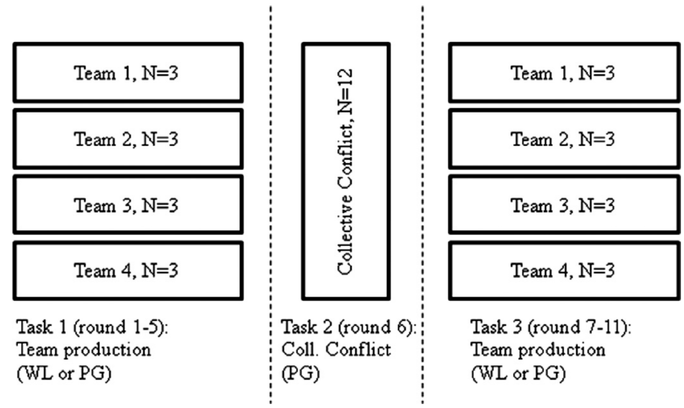


Fig. 1. Experimental procedure.

Our subjects were students at Radboud University Nijmegen, the Netherlands (64.4% male). We used z-tree (Fischbacher, 2007) for programming and ORSEE (Greiner, 2004) to recruit participants. The participants received a show-up fee of 3 Euro, plus earnings depending on their decisions in the experiment. The average earnings were 14.59 Euro ($\sigma = 3.19$), including the show-up fee, for a session lasting approximately 1 h. In a session, subjects received written instructions, which were read aloud, and completed a comprehension test.

We propose that cooperation and coordination on a team are not necessarily affected via the same mechanisms of behavioral spillovers. On the one hand, spillovers can manifest themselves as *negative reciprocity toward freeriders detected in the team-level task.* Cooperators can punish freeriders with low-effort choices in the subsequent team production. This decreases the payoffs of the freeriders, although it also entails costs for the retaliating cooperators. Cooperators are often willing to impose costly punishment on freeriders, as has been documented in experiments and in the field (Skarlicki and Folger, 1997; Fehr and Gächter, 2000a; Teraji, 2013; Robinson and O'Leary-Kelly, 1998). Negative reciprocity toward freeriders therefore implies efficiency loss, i.e., productivity decreases, independent of whether the teamwork is driven by coordination or by cooperation. Moreover, negative reciprocity toward freeriders is only expected on heterogeneous teams – composed of freeriders and cooperators in the session-wide task.

In addition to retaliation, behavioral spillovers can also allow for *learning* about the team members' preferences for cooperation versus freeriding. When team members solve a coordination problem, they form beliefs regarding the expected behavior of others. Once such beliefs are established, new information on others' preferences for cooperation, however, is not required for this purpose, as coordination on the most efficient equilibrium is in the self-interest of all team members. In contrast, when the team's production task involves cooperation, then obtaining new information on the cooperativeness of other team members might affect the team's output. On heterogeneous teams, cooperators observe freeriders and need to revise their beliefs concerning their willingness to cooperate on the subsequent team production. Heterogeneous teams are thus expected to experience a decline in productivity due to the new information concerning the presence of freeriders on the team. A similar effect might occur on homogeneous teams composed purely of freeriders but not on homogeneous teams composed purely of cooperators. However, there is another mechanism that might affect homogeneous teams – a mechanism based on group identification. The mere fact that all individuals made the same decision in the session-wide public goods game task might lead – to the same extent as inter-team competition (e.g., Bornstein and Rapoport, 1988; Bornstein and Erev, 1994) – to an increase in both group identification and the incentives to cooperate. Learning and group identification represent opposing forces in

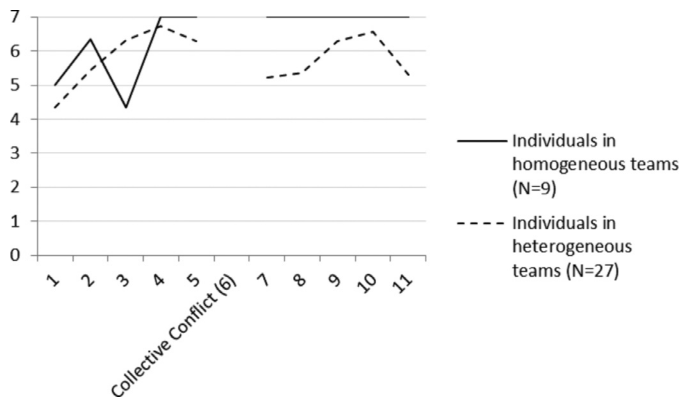


Fig. 2. Average individual efforts in the weak-link game.

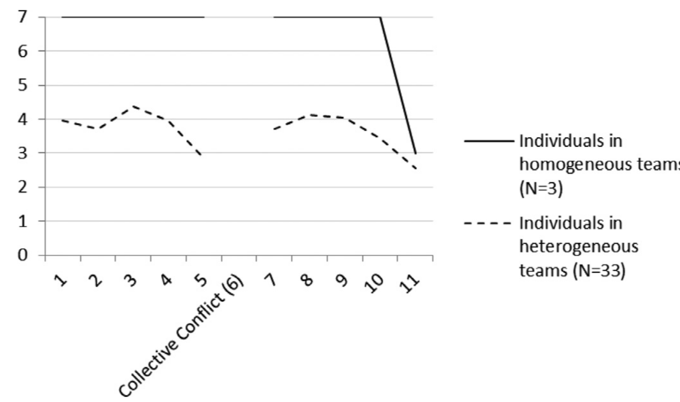


Fig. 3. Average individual efforts in the public goods game.

homogeneous teams composed of freeriders. We therefore refrain from overemphasizing the predictions for homogeneous teams and focus on predictions for heterogeneous teams. We expect that heterogeneous teams will unambiguously experience a decline in efficiency in the public goods game production task due to learning. In summary, we hypothesize that efficiency in heterogeneous teams will decrease in both the weak-link and the public goods game due to negative reciprocity and only in the public goods game if spillovers are exclusively driven by learning.

3. Results

We first summarize behavior in the session-wide, step-level public goods game before analyzing the team production and the impact of this firm-level event on team productivity. In total, 29 out of our 72 participants contributed their participation fees to produce the session-side public good (mean per session = 4.83; $\sigma = 0.89$). Of our 6 session-wide conflicts, 5 were successful; that is, at least four participants in the session contributed their participation fees. Recall that we did not provide any feedback regarding the outcome of the session-wide public goods game during the experiment. We therefore set aside the actual realization of the session-wide public good when analyzing the data on team efficiency. Instead, we focus on the information that was available to the team members, that is, information on each team member's participation during the session-wide public-good event.

We label teams composed of subjects who acted in concert during this event – either all cooperated or all free rode –homogeneous teams. Teams in which one or two subjects cooperated in the session-wide public goods game while the other(s) decided to free ride are labeled heterogeneous teams.[3] We observed one homogeneous team in the public goods treatment and three homogeneous teams in the weak-link treatment. Due to this low number of observations, we must be cautious making statistical statements regarding the team-level outcomes of homogeneous teams. Henceforth, we focus on individuals in either heterogeneous or homogeneous teams and only report the data on homogeneous teams for completeness.

Figs. 2 and 3 display the average individual efforts before and after the session-wide event in the WL and PG treatments and for homogeneous and heterogeneous teams.

The figures display the average contributions. A closer examination of teams and individuals reveals interesting differences between them. First, let us discuss the production in both games before the session-wide event. Despite the subjects being able to adjust their effort any number of times within the 2 min of one interaction round, we find that in neither game did the teams succeed in generating the maximum efficiency (effort level 7), except for one team in the public goods game treatment. This is not entirely surprising in the public goods treatment, in which any team member has an incentive to revert to the individually rational effort level, equal to 1, at the last second, and thus free ride on the team. The opportunity to develop trust may mean that the cheap-talk might be simply too weak an instrument to allow team members to develop sufficient trust to adjust effort levels and thus sustain efficiency in the public goods game.

The failure to sustain the most efficient outcome in weak-link games is more surprising. Even when the subjects "only" need to coordinate on what equilibrium to play, their behavior is not consistent with the most efficient Nash equilibrium (effort level 7). However, these observations are consistent with those made by authors using designs involving real-time strategy adjustment. Knez and Camerer (2000), for instance, report very similar results when comparing a weak-link treatment to a related public goods game.[4]

To provide initial insights into behavioral spillovers from the session-wide public goods game event to the subsequent production in teams, we present Table 3, which reports team-level production. This table contains three team-level statistics: (1) the average team-level effort over the rounds before and after the session-wide event and (2) the team-level effort in the first interaction at the beginning of the experiment (round 1), the team-level effort immediately before the session-wide event (round 5), and (3) team-level effort immediately after the session-wide event (round 7).

To account for idiosyncrasies within groups, we perform a Wilcoxon paired test on the average team effort before and after for both treatments. We find that efficiency declines significantly in the public goods treatment: the overall average team effort equals 11.9 before the session-wide event, but it equals 7.5 after, and the difference is significant ($p = 0.0029$). The corresponding overall average efforts before and after the session-wide event in the weak link game are not significantly different from one another, equal to 17.20 and 15.68 ($p = 0.5560$).[5] Concerning differences of contributions between the pre- and the post-conflict contributions, we find that individuals in heterogeneous teams in the public good treatment significantly drop their contributions after the conflict (mean before = 11.07 versus mean after = 6.53, $p = 0.0044$), while contributions of individuals in homogeneous teams and in the weak-link setting (both homogeneous and heterogeneous teams) do not significantly differ when comparing pre- and post-conflict contributions.

3 For completeness, Fig. A.1 depicts the trend of the effort choices in all teams in our experiments.

4 Their research focused on the question of whether the cooperation learned in a weak link situation affects the results of a subsequent public goods experiment.

5 The results remain unchanged when we only include heterogeneous groups. The average pre- and post-session-wide event effort is 11.07 and 6.53, respectively ($p = 0.0044$), in the public goods treatment, while it is 17.00 and 13.91 ($p = 0.173$) in the weak-link treatment.

Table 3
Summary of team efforts, before and after the session-wide public goods game.

Group ID	Treatment	# cooperators	Heterogeneous team	Average team effort in rounds		Team effort in round		
				1–5	7–11	1	5	7
14	PG	1	Yes	12.0	8.4	21	3	3
17	PG	1	Yes	18.6	9.0	21	9	9
18	PG	1	Yes	19.0	5.4	21	11	9
20	PG	1	Yes	6.8	5.8	9	10	4
15	PG	1	Yes	7.8	3.8	9	6	7
22	PG	1	Yes	4.6	4.8	7	3	6
13	PG	1	Yes	5.4	3.0	3	3	3
16	PG	1	Yes	12.4	10.2	4	11	4
23	PG	1	Yes	5.4	3.4	3	7	5
21	PG	2	Yes	18.0	8.6	21	6	8
24	PG	2	Yes	11.8	9.4	12	11	9
19	PG	0	No	21.0	18.6	21	21	21
11	WL	1	Yes	21.0	5.4	21	21	9
12	WL	1	Yes	17.8	18.4	18	21	12
4	WL	1	Yes	12.6	15.6	4	15	3
1	WL	1	Yes	18.2	12.2	12	21	12
9	WL	1	Yes	18.8	19.0	10	21	17
8	WL	2	Yes	15.4	13.2	17	4	3
2	WL	2	Yes	20.4	18.4	18	21	15
10	WL	2	Yes	11.0	5.4	5	10	3
3	WL	2	Yes	17.8	17.6	12	14	15
5	WL	0	No	21.0	21.0	21	21	21
7	WL	0	No	13.2	21.0	3	21	21
6	WL	3	No	19.2	21.0	21	21	21

Taking both tests together, these observations suggest that there are spillovers from the session-wide event that negatively affect the productivity of the teams, at least in the case of teams solving the cooperation problem. This effect cannot solely be attributed to the restart effect, as the declines in effort that we observe differ from typical restart effects. Typically, a restart in public goods or weak-link games involves an upward jump in efficiency (e.g., Andreoni, 1988; Croson, 1996, 2000; Fehr and Gächter, 2000b), while we generally observe an immediate decrease, see the round 5 and round 7 effort levels in Table 3.[6]

We now turn to a discussion of the effects of the session-wide event on individual effort levels. We estimated a Tobit regression model to analyze the impact of the session-wide conflict (see Table 4)[7] on individual effort. Our dependent variable *effort* is each individual effort in rounds $t = 7$–11 (after the session-wide event occurred), leading to 180 observations (36 individual decisions times 5 rounds). To account for the nested structure of our data, we apply robust standard errors clustered at the team level.[8]

As independent variables, we constructed past team productivity during the period before the session-wide conflict occurred by calculating the mean team effort in rounds 1–5 ($team\_effort_{avg1-5}$). We further control for the round of interaction (*round, varying from 7 to 11*) to capture learning or any end-game effects not linked to the session-wide event. The main explanatory variables address the impact of the session-wide event. The dummy *Heterogeneous* equals 1 in the periods after the session-wide event on teams that observed that both freeriders and cooperators compose the team, and the dummy *Cooperator* equals 1 in the periods after the session-wide event for subjects that cooperated during the session-wide event.

Table 4
Tobit regression explaining individual effort (*effort in rounds 7–11*).

	Model 1(WL) (a)	Model 2 (PG) (b)
Constant	2.046*** (0.528)	5.357*** (1.586)
Round	0.088** (0.012)	−0.429** (.187)
Mean team contribution pre-conflict ($team\_effort_{avg1-5}$)	0.227*** (0.061)	0.203*** (0.034)
Cooperator session wide event (reference group = freerider)	−0.114 (0.163)	0.083 (0.372)
Heterogeneous team (references group = homogeneous teams)	−1.552*** (0.352)	−0.606** (0.243)
Log likelihood	−349.466	−406.121
N	180	180
Pseudo R^2	0.1098	0.1081

Standard errors are in parentheses. LL (1); UL (7). * $p \le 0.10$; robust standard errors clustered at the team level.
** $p \le 0.05$; robust standard errors clustered at the team level.
*** $p \le 0.01$, robust standard errors clustered at the team level.

Based on the discussion in the theory section, we expect that efficiency will be negatively affected on heterogeneous teams, and the various mechanisms of behavioral spillovers will affect either only cooperation in teams (in the PG treatment, via learning about the team members' preferences) or both cooperation and coordination on teams (in the PG and WL treatments, via sanctioning of freeriders).

The efficiency of team production, as captured by the individual effort choices of team members, is lower after the session-wide event for heterogeneous teams compared to homogeneous teams after controlling for other influences. We find this effect in both the weak-link game and the public goods game. The regression results lend support to the hypothesis that lower efforts displayed in Table 3 are associated with negative spillovers in heterogeneous teams, while homogeneous teams at least maintain their efficiency level.

6 Our data also offer some indications that homogeneous groups do not suffer from productivity declines or are even able to improve productivity. This is in line with Burlando and Guala (2005) and deserves further investigation in the future.

7 We were also interested in the interaction between contribution in the session-wide experiment and subsequent behavior. As we have too few observations of contributors to the session-wide event in homogeneous groups in the public goods treatment, we can only analyze this aspect for the weak-link teams (for results, see Appendix B). Participants in the weak-link setting contribute significantly less to the joint production after the collective conflict in heterogeneous groups, which can be interpreted as a punishment action against their non-contributing colleagues.

8 Because we use one team-level control variable (team effort in rounds 1–5), we also estimate Tobit regressions with clustered standard errors at the individual level. The results remain the same, even with respect to effect size.

5. Discussion

We sought to experimentally identify behavioral spillovers from a firm-level event to the subsequent productivity of teams. Using experimental methods, we are able to identify the relevance of such spillovers for two common types of team tasks: coordination and cooperation. We model these tasks in the experiments as a weak-link game and a public goods game, respectively. Both games are parameterized such that subjects can achieve the same maximal efficiency but the efficient outcome is only supported by individually rational behavior (in Nash equilibrium) in the weak-link game, and hence not in the public goods game. The firm-level event has the characteristics of a social dilemma, in which individual interests are in conflict with the interests of all firm workers. We implement this conflict as a step-level public goods game in which all subjects in a given session (in a firm) share the fixed cost of public goods provision, provided that a certain threshold number of cooperators has been reached. This approach captures the features that (i) the cooperation of all individuals is not necessary to produce the public good but (ii) the cooperation of all individuals is necessary to produce the firm-level public good at the lowest possible individual cost. This is the case because the fixed cost of the firm-level public good is only shared by the individuals who cooperate in the session-wide public good game. In this way, an individual's action can be interpreted as a signal of that individual's cooperativeness. After the session-wide event, we informed team members of the actions selected by all of their team members during this event and then restarted the team production.

Our findings contain clear evidence that collective conflicts affect collaboration in teams. Remarkably, collective conflicts do not generally reduce productivity after the conflict is over. Instead, how individuals work together (cooperation or coordination) and group composition within the team have crucial effects on team performance.

One important observation we made is the special behavior of homogeneous groups: Homogeneous teams maintain their effort levels they have reached before and after the collective public good game. The spillover mechanisms we discuss offer less straightforward predictions for homogeneous teams. One straightforward explanation is that there is no one freeriding on the expense of the other team members in the session-wide public good conflict and therefore simply no need to punish. Another possibility is that learning about the team members occurs and the observation that the other team members are alike increases the efficiency of these teams after a session-wide event. As we have only four groups where the members acted in concert, this finding must be supported by future research; however, the behavior of these 12 individuals in homogeneous groups leads us to assume that acting in concert during a conflict might serve as a coordination or cooperation device.

Conversely, individuals in teams that are mixed with respect to contributions in the organization-wide collective conflict find it difficult to even return to their former team productivity. Such findings are consistent with propositions of social cohesion theory (Carless and DePaola, 2000; Sargent and Sue-Chang, 2001; Takleab, Quigley, and Tesluk, 2009; Drouvelis and Nosenzo, 2013), suggesting that the social cohesion within a team enhances cooperation, even if it results from processes unrelated to the production itself. In this way, collective conflicts might improve team efficiency if homogeneity among team members is achieved, such that a team spirit emerges from conflicts and social dilemmas. We conclude that based on our data, behavioral spillovers negatively affect heterogeneous teams in coordination and cooperation situations.

Our findings stimulate further research questions. (1) The nature of our collective conflict was relatively severe. The gains from a successful collective action represented approximately 40% of the participants' total earnings. If collective conflicts are analyzed in the future, smaller events, such as collective actions that represent only 10% of the total earnings, should also be analyzed. Given our results, it would be interesting to determine whether the punishment patterns that we observe would be the same in the less severe conflict situations and whether the amount of team productivity losses would be the same.

(2) For reasons of simplicity, we only analyzed three-person teams and introduced a collective conflict at the laboratory-wide level. Other research analyzing symmetric conflicts between two teams, as well as all research on public goods conflicts, indicates that team and group size is important not only for punishment actions but also for team cohesion after the conflict (e.g., Halevy, Bornstein, and Sagiv, 2008). Thus, further research on the interplay of dynamic and intra-team conflicts should also account for other, more dynamic work situations and other group sizes such as dyadic relationships and a larger group size.

(3) Finally, we only analyzed situations with symmetric contributions to the collective action. However, to take, for instance, union membership and compensation from the union's strike fund into account, one can also easily imagine asymmetric conflict situations in which the participants experience different costs to joining in a collective action. Thus, a combination with the research design developed by Brandts, Cooper, and Fatas (2007) could provide further information on the sanctioning affect in asymmetric situations.

(4) We need to better understand the mechanisms that cause homogeneity to improve performance. Two main sequences are possible, indicating different explanations and different practical implications. One possibility is that acting alike in a conflict situation improves team performance because the members perceive greater levels of cohesion and have higher levels of trust in one another. In that case, the management implication would be to attempt to not divide teams and to provide members with the perception that they are alike. A second explanation would be the possibility that path-dependency is causing such behavior. Well-functioning teams might be more likely to act in concert and then improve performance, as their common experience triggered a self-reinforcing mechanism. If this is the case, performance changes might not be exclusively due to the collective conflict but rooted in very early experiences of the team. Our first experiment on multi-level conflict, however, is not well suited to reveal the causal mechanisms in detail. However, despite all of their limitations, our findings are a first step toward measuring the long-term consequences of conflicts. We demonstrate that, overall, teams experience severe difficulties in continuing coordination after a collective conflict. However, the magnitude of the coordination problems differs with respect to the incentive structure provided by the institutional setting and group composition. While the first factor is obviously subject to a firm's strategic choices, the latter is more difficult to influence. However, even the group composition can be affected by the firm's communication: if firms are able to enforce or support solidarity among their employees in a collective conflict situation, the joint action can not only dampen the long-term consequences of strike actions but also improve performance and thereby compensate for the losses originated by the strike action itself. Preliminary case studies indicate that most firms do not possess a communication strategy for crises and, moreover, the very few firms that do have a communication strategy tend to divide the group of employees up instead of triggering cooperation. Our results indicate that these strategies might only be an advantage in the short run and are clearly a disadvantage in the long run after the conflict. Additionally, our research stresses the importance of diversity for group performance. Consistent with previous research on diversity (e.g., Dovidio and Gaertner, 2000; Thommes and Akkerman, 2014), we obtain strong evidence that the diversity of the teams affects group performance. However, the fault lines between the teams and diversity in the teams need not be associated with stable personal characteristics; they can also be the result of behaviors and crucial actions. Moreover, our findings suggest that the behavior-related fault lines can also severely disturb

intra-group relationships and can be directly linked to interpersonal trust. Based on our analysis, we assume that not only a strike but also other conflicts can trigger behavior-related fault lines between employees that can hamper production because beliefs are updated and the level of uncertainty regarding the other team members changes. The direct link to uncertainty could also be an explanation for why collective conflicts can improve performance if homogeneity among team members is achieved. Under this assumption, team spirit can emerge from conflicts and social dilemmas.

Appendix A

Fig. A.1.

A.1. Instructions for the weak link game

You will now participate in an experiment on economic decision-making. The experiment will last approximately 1.5 h. You will be paid after the experiment. No other experiment participant will learn how much you earned. You will be paid 3 Euros for your participation PLUS any additional earnings you will make in the experiment. How much you earn crucially depends on your decisions in the experiment.

In the experiment, you will participate in three tasks. Your earnings will be in points in task 1 and task 3 and in Euro in task 2. At the end of the experiment, you will also be paid for all of the points you earned.

$$\text{The exchange rate is :100 points} = 1 \text{ Euro}, 1 \text{ point} = 1 \text{ Euro cent.}$$

You are not allowed to talk to other participants from now on. Disobeying this rule will result in your exclusion.

Task 1:

In this task, you will be assigned to a team consisting of three participants. Each team member will be assigned one number, 1, 2 or 3. This will be the only way the identity of a team member will be known to you.

You will participate in five rounds. The team composition will be the same in all five rounds.

In each round, you and the other two team members will have 2 min to choose your own effort from possible effort levels 1, 2, 3 ... up to 7.

You will first make an initial choice of your effort at the same time as the other team members. Then, you will observe the initial choices of all three team members, and you will receive 2 min time.

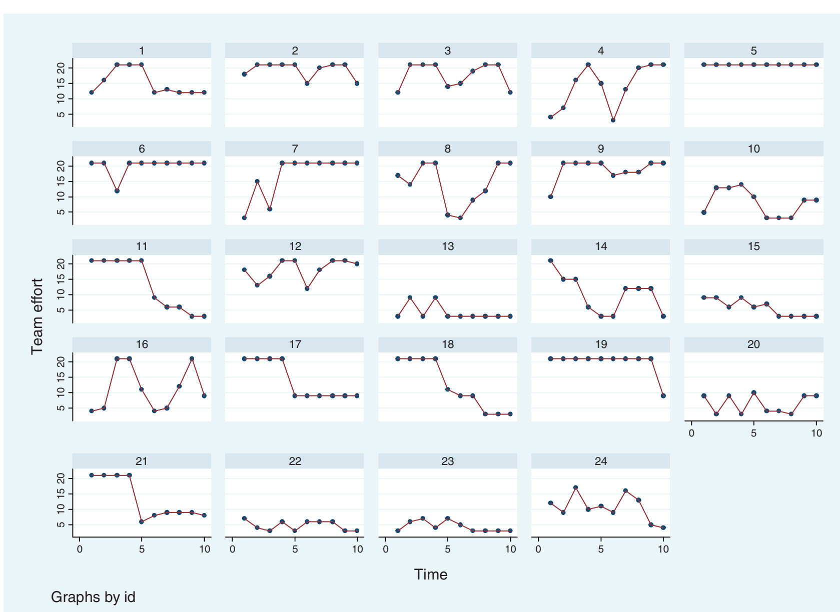
During these 2 min, you will be able to adjust your initial effort in any way at any moment, and you will be able to observe the possible adjustments of the other two team members. At the end of these 2 min, your last stated effort will be your final effort. Your final effort and the final efforts of the other two team members determine how much you earn in this round.

Your earnings in one round depend on the lowest final effort chosen on your team, and on your own final effort according to the following formula:

$$\text{Your earnings in one round} = 60\ \underline{\text{PLUS}}\ 20 * \text{the lowest final effort chosen in the team}\ \underline{\text{MINUS}}\ 10 * \text{your final effort}$$

Here, the lowest final effort is the lowest effort level chosen as a final effort on your team. That is, it can be your own final effort, or the final effort of some other team member. Note the following: the gain that will be ADDED to your earnings depends on the lowest final effort in the team; the costs that will be SUBTRACTED from your earnings depend only on your own final effort.

When making your decisions, you can use the above formula, but you can also make use of the table below. The table contains the



Note: groups 1-12 = weak-link groups, groups 13-24 = public good groups.
Group composition concerning contributors to the firm-level public good between rd5 and rd6:
0 contributors in #5, 7, 19
1 contributor in #1, 4, 9, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, 23
2 contributors in # 2, 3, 8, 10, 21, 24
3 contributors in # 6

Fig. A.1. Efforts per group over time.

number of points you can earn depending on the final effort *you* choose and on the lowest final effort in the team. Please have a look at the payoff table now.

The payoff table (payoffs in points)							
Your final effort	The lowest final effort in the team						
	7	6	5	4	3	2	1
7	130	110	90	70	50	30	10
6	–	120	100	80	60	40	20
5	–	–	110	90	70	50	30
4	–	–	–	100	80	60	40
3	–	–	–	–	90	70	50
2	–	–	–	–	–	80	60
1	–	–	–	–	–	–	70

In the first column, you can find all possible effort levels that you might choose. In the first row, you can find all possible situations that can arise with respect to the lowest effort in your team.

Please raise your hand if you have any questions.

The experiment now starts with a short test to make sure that everybody understands how points are earned. Use the payoff table to answer the following questions. After all experiment participants have answered all questions correctly, the experiment will begin.

Task 2:

You will now participate in Task 2 of the experiment. This second task is a collective action task and can significantly affect your earnings. Depending on your and others' decisions on this task, you can double your participation fee for your final earnings.

In this task, each participant in the room will make one decision only. The decisions of all participants in the room will affect your earnings, and your decision will affect the earnings of all participants in this room.

In this task, you will decide to JOIN IN or STAY OUT of the collective action. If you choose to JOIN IN, you are giving your participation fee of 3 Euro to increase the earnings of ALL experiment participants, including yourself, by an extra benefit of the collective action equal to 6 Euro.

The payoffs of ALL experiment participants will be increased by 6 Euro if FOUR or more participants contribute their 3 Euro to the collective action.

The total costs of the collective action are 12 Euro for all participants in this room together. The 12 Euro will be equally divided among the subjects who choose to JOIN IN and thus contribute their 3 Euro. The subjects that choose to STAY OUT will pay no costs for the collective action, but they will receive the 6 Euro.

If fewer than FOUR participants in this room contribute their participation fee of 3 Euro to the collective action, then and no one will receive the extra bonus of 6 Euros. Moreover, those participants that choose to JOIN IN will lose their participation fee of 3 Euro. The participants that choose to STAY will lose nothing and gain nothing in this case.

Task 3:

In this task, you will again be assigned to a team of three participants. These will be the same participants as in Task 1. You will again participate in five rounds, and the team composition remains the same.

Again, you will choose an initial effort level from the possible levels: 1 (lowest), 2, 3 . . . up to 7 (highest), and you will receive 2 min for possible adjustments. During these 2 min, you will be able to adjust your initial decision (after you have observed the initial decisions of the other team members). Your earnings in one round are determined in the same way as in Task 1.

The only additional information you will receive on the computer screen compared to Task 1 is the information about your team members, namely the decisions the team members made in Task 2. You will learn whether they JOINED IN the collective action or STAYED OUT, and your team members will learn about your decision in Task 2.

Please raise your hand if you have any questions.

A.2. Instructions for the public goods game

You will now participate in an experiment on economic decision-making. The experiment will last approximately 1.5 h. You will be paid after the experiment. No other experiment participant will learn how much you earned. You will be paid 3 Euro for your participation PLUS any additional earnings you make in the experiment. How much you earn crucially depends on your decisions in the experiment.

In the experiment, you will participate in three tasks. Your earnings will be in points in Task 1 and Task 3 and in euro in Task 2. At the end of the experiment, you will also be paid for all of the points you earned.

$$\text{The exchange rate is :100points} = 1\ \text{Euro},\ 1\ \text{point} = 1\ \text{Euro cent}.$$

You are not allowed to talk to other participants from now on. Disobeying this rule will result in your exclusion.

Task 1:

In this task, you will be assigned to a team consisting of three participants. Each team member will be assigned one number, 1, 2 or 3. This will be the only way the identity of a team member will be known to you.

You will participate in five rounds. The team composition will be the same in all five rounds.

In each round, you and the other two team members will have 2 min to choose your own effort from possible effort levels 1, 2, 3 . . . up to 7.

You will first make an initial choice of your effort at the same time as the other team members. Then, you will observe the initial choices of all three team members, and you will receive 2 min time.

During these 2 min, you will be able to adjust your initial effort in any way at any moment, and you will be able to observe the possible adjustments of the other two team members. At the end of these 2 min, your last stated effort will be your final effort. Your final effort and the final efforts of the other two team members determine how much you earn in this round.

Your earnings in one round depend on the sum of all final efforts chosen on your team and on your own final effort according to the following formula:

$$\text{Your earnings in one round} = 60\ \underline{\text{PLUS}}\ (20/3)\ ^{*}\ \text{sum of all final effortsin the team}\ \underline{\text{MINUS}}\ 10\ ^{*}\ \text{your own final effort}$$

Note the following: the gain that will be ADDED to your earnings depends on each team member's effort; the costs that will be SUBTRACTED from your earnings depend only on your own final effort.

When making your decisions, you can use the above formula, but you can also make use of the table below. The table contains the number of points you can earn depending on the final effort *you* choose and on the lowest final effort on the team. Please, have a look at the payoff table now.

The payoff table (payoffs in points)													
Your final	Sum of efforts of your team members												
effort	14	13	12	11	10	9	8	7	6	5	4	3	2
7	130	123	117	110	103	97	90	83	77	70	63	57	50
6	133	127	120	113	107	100	93	87	80	73	67	60	53
5	137	130	123	117	110	103	97	90	83	77	70	63	57
4	140	133	127	120	113	107	100	93	87	80	73	67	60
3	143	137	130	123	117	110	103	97	90	83	77	70	63
2	147	140	133	127	120	113	107	100	93	87	80	73	67
1	150	143	137	130	123	117	110	103	97	90	83	77	70

In the first column, you can find all possible effort levels that you might choose. In the first row, you can find all possible situations that can arise with respect to the sum of your team members' efforts.

Please raise your hand if you have any questions.

The experiment now starts with a short test to make sure that everybody understands how points are earned. Use the payoff table to answer the following questions. After all experiment participants have answered all questions correctly, the experiment will begin.

Task 2:

You will now participate in Task 2 of the experiment. This second task is a collective action task and can significantly affect your earnings. Depending on your and others' decisions in this task, you can double your participation fee for your final earnings.

In this task, each participant in the room will make one decision only. The decisions of all participants in the room will affect your earnings, and your decision will affect the earnings of all participants in this room.

In this task, you will decide to JOIN IN or STAY OUT of the collective action. If you choose to JOIN IN, you are giving your participation fee of 3 Euro to increase the earnings of ALL experiment participants, including yourself, by an extra benefit of the collective action equal to 6 Euro.

The payoffs of ALL experiment participants will be increased by 6 Euro if FOUR or more participants contribute their 3 Euro to the collective action.

The total costs of the collective action are 12 Euro for all participants in this room together. The 12 Euro will be equally divided among the subjects who choose to JOIN IN and thus contribute their 3 Euro. The subjects that choose to STAY OUT will pay no costs for the collective action, but they will receive the 6 Euro.

If fewer than FOUR participants in this room contribute their participation fee of 3 Euro to the collective action, then no one will receive the extra bonus of 6 Euros. Moreover, those participants that choose to JOIN IN will lose their participation fee of 3 Euro. The participants that choose to STAY OUT will lose nothing and gain nothing in this case.

Task 3:

In this task, you will be again assigned to a team of three participants. These will be the same participants as in Task 1. You will again participate in five rounds, and the team composition remains the same.

Again, you will choose an initial effort level from the possible levels: 1 (lowest), 2, 3 . . . up to 7 (highest), and you will receive 2 min for possible adjustments. During these 2 min, you will be able to adjust your initial decision (after you have observed the initial decisions of the other team members). Your earnings in one round are determined in the same way as in Task 1.

The only additional information you will receive on the computer screen compared to Task 1 is the information about your team members, namely the decisions the team members made in Task 2. You will learn whether they JOINED IN the collective action or STAYED OUT, and your team members will learn about your decision in Task 2.

Please raise your hand if you have any questions.

Appendix B

Table B.1.

Table B.1
Tobit regression explaining individual effort ($effort_t$).

	Model 1 (WL)	
	(a)	(b)
Constant	2.046*** (0.528)	2.046*** (0.884)
Round	0.088** (0.012)	0.0186 (0.112)
Mean team contribution pre-conflict ($team\_effort_{avg1-5}$)	0.227*** (0.061)	0.227*** (0.062)
Cooperator session-wide event (reference group = freerider)	−0.114 (0.163)	1.114*** (0.161)
Heterogeneous team (references group = homogeneous teams)	−1.552*** (0.352)	−1.539*** (0.496)
Cooperator* heterogeneous group		−0.100** (0.051)
Log likelihood	−349.466	−322.465
N	180	180
Pseudo *R*	0.1098	0.1200

Standard errors are in parentheses. LL(1); UL (7).
* $p \leq 0.10$; robust standard errors clustered at the team level.
** $p \leq 0.05$; robust standard errors clustered at the team level.
*** $p \leq 0.01$, robust standard errors clustered at the team level.

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