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Team production and gift exchange

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ABSTRACT

We study the effect of communication in a team production experimental setting where a principal decides, before contributions are made, how the team output will be allocated between himself and the team members. The allocation determines the marginal per capita rate of contributions. Without communication, we observe that high offers by the principal are followed by larger contributions by the team members (gift-exchange). With communication, only positive messages have a significant effect on the team members' contributions: (i) positive messages increase workers' contributions in those cases in which they receive the low offer and (ii) positive messages are accompanied of high offers to team members.

1. Introduction

Team production faces the free-rider problem, where individual incentives are at odds with efficient outcomes (Holmström, 1982). The linear voluntary contribution mechanism (VCM) setting (Isaac & Walker, 1988) has spurred a large experimental literature on how to promote cooperation in groups, with many different mechanisms being used (for example, punishment Alventosa et al., 2021; Fehr & Gächter, 2000; Kosfeld et al., 2009; Traulsen et al., 2012; feedback Bigoni & Suetens, 2012; Faillo et al., 2013; Nikiforakis, 2010; exclusion Croson et al., 2015; communication Haruvy et al., 2017, among others).

In this paper, we enlarge the VCM setting by adding, prior to the contribution stage, a principal who decides how much of the team output he keeps for himself and how much will be equally distributed among the workers. In this setting, we study the effectiveness of one-side communication on the part of the employer on the efforts chosen by team members.

The enlarged VCM, where the principal's choice sets the marginal per capita rate (MPCR) that team members will face, is reminiscent of the agency problem (Mirrlees, 1999) and places our research in the experimental gift-exchange literature, where a principal offers a wage, and the worker can reciprocate by exerting higher efforts associated with higher salaries. In line with the experimental literature which documents the existence of reciprocity in the labour market (see Fehr et al., 1997 or Hannan et al., 2002) with long-run effects (Fehr et al., 1998; Gächter & Falk, 2002), our results show that, in the absence of communication, high offers by the principals result in significantly higher contributions on the side of the workers, although their choices are distant from full contribution.

In this setting we analyse the effect of non-binding communication from principals to workers when offering the contract by means of pre-specified messages. One message has a "positive" nature, in which employers anticipate their gratitude for high contributions, another one has a"negative" connotation, in which employers express their disappointment from receiving low contributions, and the third one expresses an "expectation" of high contributions.

Communication might play a positive role in our setting as there is experimental evidence that reports that non-binding communication enhances reciprocity (Charness & Dufwenberg, 2006), reduce free-riding behaviour (Isaac & Walker, 1988), or solves coordination failures (Brandts & Cooper, 2007). With regard to communication in labour markets, non-binding communication has been shown to work in Cooper and Lightle (2013), that allowed employers and employees to freely communicate about their wage and effort decisions. In this case, communication was shown to be effective from employees to employers, who demanded higher wages in order to exert greater levels of effort. Moreover, communication in Public Goods Games (PGG) has

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been shown to increase contributions and, consequently, cooperation (Haruvy et al., 2017).

We find in our communication treatment that only positive messages have a significant effect on the workers' contributions. They do it both through a direct channel (by increasing workers' contributions in those cases in which they receive the low offer) and by indirect channel, since employers sending positive messages and offering a high share of the common project are positively correlated.

The closest paper to ours within the experimental literature is Cason et al. (2020), which also combines a social dilemma with a gift-exchange framework. In their setting, a single principal–agent relationship involves an agency problem, in which the principal offers a wage and specifies the desired level of (non-verifiable) effort from the agent (gift exchange). However, given the agent's choice, if a bad outcome occurs, it imposes a negative externality on other principals, thereby creating a social dilemma. Our approach is different. In our case, we have a multiple agent setting, in which the social dilemma occurs among agents, not with regard to other principals. In a recent follow-up to this study, Cason et al. (2025) introduce communication treatments. Communication takes the form of either a single private message from the agent to the principal in each pair (i.e., in the opposite direction to ours), or an open chat among all agents and principals whose payoffs are affected by the agents' actions.

Finally, a strand of the literature closely related to ours is the punishment literature in PGG, particularly in settings where the share of the public good is determined ex-post as a reward or punishment for individual contributions. Some studies examine allocators who play a dual role in the game, first contributing and then deciding on the allocation of the public good, either following an egalitarian approach (Karakostas et al., 2023) or a leadership approach (Van der Heijden et al., 2009). Other authors have analysed the effects of delegating the allocation power to a third party external to the game (Cox & Stoddard, 2024), as well as compared different allocation rules (Drouvelis et al., 2017; Stoddard et al., 2021, 2014). However, mere spectators of a game have been shown to respond more to generosity of others than stakeholders due to moral biases (Croson & Konow, 2009). In contrast, in our case, the share of the public good allocated to the contributors is determined ex-ante, which allows us to investigate the reciprocity motive per se.

The remainder of the paper is organized as follows. In Section 2, we present the theoretical model, the experimental design, and our main hypotheses. Section 3 presents our results. In Section 4 we conclude.

2. The experiment

In this section, we present the theoretical model of team production with an active principal. Then, we discuss the experimental design and state the main hypotheses.

2.1. The game and hypotheses

We consider a group of four: One employer ($i = 0$) and three workers ($i = 1, 2, 3$). The four members participate in a common project with the structure of a VCM. The employer's task is to decide how the team output is allocated, whilst the workers decide with how much of their initial endowment they contribute to the common project.

This sequential game has two stages:

- *The distribution stage* - The employer decides how to allocate the team output between him and the workers. He does so by choosing the proportion $\gamma \in [\frac{1}{2}, 1]$ of the project that the workers will receive evenly, being $(1 - \gamma)$ the proportion that the employer keeps for himself. Moreover, the employer also chooses a non-binding message, $m \in M$, to send to all the workers. We consider two versions of the game: A game without communication (i.e., with $M = \emptyset$) and a game with communication in which, in addition to the possibility of sending no message, the employer can send a pre-specified message with a positive, an expectant or a negative connotation (i.e., with $M =$ {Positive, Expectation, Negative, Empty}).[1]
- *The contribution stage* - Workers are informed about the value of γ chosen and each decides unilaterally how much of their individual endowment ω to contribute to the common project (c_i) and how much to keep for himself/herself ($\omega - c_i$). The size of the common project is the sum of the worker's contributions multiplied by a technological parameter of size 2.

The employer's payoff is:

$$\pi_0(c_i, \gamma) = (1 - \gamma) \cdot 2 \cdot \sum_{i=1}^{3} c_i \tag{1}$$

Each worker's payoff is:

$$\pi_i(c_i, \gamma) = \omega - c_i + \frac{\gamma}{3} \cdot 2 \cdot \sum_{i=1}^{3} c_i \tag{2}$$

Note that for any value of γ and message m chosen by the employer, contributing with zero is the dominant strategy for workers in the contribution stage, because the individual return from contributing to the team project, $2\gamma/3$, is smaller than 1, which is the return from the private good. Therefore, abstracting from the benefit to the employer, there is a social dilemma among the workers in the contribution stage whenever $\gamma \geq 1/2$. This is so since their aggregate payoff, $3\omega + (2\gamma - 1) \cdot \sum_{i=1}^{3} c_i$, is maximized in case of full contributions (i.e. $c_i = \omega$, $\forall i \in \{1, 2, 3\}$) in such a case.[2] In our experimental setup, we restrict the choice of γ to two possible values: $\gamma = 1/2$ (low offer) and $\gamma = 3/4$ (high offer).

Using backward induction arguments, individual workers' incentives are to contribute $c_i = 0$ to the common project. Anticipating this, the employer is indifferent about which message m to send, if any, and which fraction γ to offer to workers in the distribution stage.

Our goal is to explore the impact of two variables on contributions. On the one hand, we analyse the effect of the offer, γ, on contributions, in order to detect a potential reciprocity (gift exchange) between employers and workers. On the other hand, we study the effect that the non-binding communication from the employer to the workers has on contributions. With this end, we present null hypotheses based on the standard selfish preferences theory, and alternative hypotheses based on behavioural models.

We first discuss our hypothesis on gift exchange and reciprocity. As previously anticipated, under standard assumptions, contributing with zero is a dominant strategy for any value of γ, what makes the employer indifferent between offering $\gamma = 1/2$ or $\gamma = 3/4$. Hence, our first hypothesis comes.

H_0 : *There are null contributions to the group project for any value of the offer, γ.*

However, things may change if a selfish employer assigns a small probability to the possibility of workers having strictly positive contributions, thinking that workers might be reciprocal. In this case, we could expect positive contributions on the side of the workers as a response to high offers made by the employer. In this regard, while prior experimental literature has mostly studied the effects of the (ex-post) distribution of the public good as a punishment/reward to individual observed contributions (Cox & Stoddard, 2024; Drouvelis et al., 2017; Karakostas et al., 2023; Stoddard et al., 2021, 2014; Van der Heijden et al., 2009), this work studies the reciprocity motive itself. This is so since the distribution is decided before the contributions.

[1] See Section 2.2 for details.

[2] Note that in case we had a standard VCM with three players, i.e. without an employer (or with an exogenous value of $\gamma = 1$), the MPCR with equal shares would be 2/3. This possibility is briefly discussed in Section 4.

Literature on reciprocity in the labour market is vast using diverse methodologies. There are theoretical models (Akerlof, 1982; Akerlof & Yellen, 1990), laboratory experiments (Brandts & Charness, 2004; Englmaier et al., 2014; Falk & Kosfeld, 2006; Fehr et al., 1997, 1998; Gächter & Falk, 2002; Hannan et al., 2002; Kube et al., 2012), and field experiments (Gneezy & List, 2006). These works have shown the rise of profitable labour interactions under reciprocity norms. Such reciprocity makes employers offer wages that are greater than the competitive wage, and makes employees exert levels of effort that surpass the minimum effort. Both parties, employers and employees, seem to understand the long-run benefits of this reciprocal interactions, which makes the effect prevail over time.

Previous experimental findings in VCM show that a significant proportion of subjects display social preferences, such as reciprocity. This leads to positive average contributions, specially in the first rounds of the game. However, the presence of free riders makes contributors end up free-riding as well. These results suggest a combination of selfish individuals and conditional cooperators in the lab.

A reciprocal employer could find optimal to offer $\gamma = 3/4$ at the beginning of each block expecting this to raise contributions from which he can benefit. This, in turn, could be understood as a gift from the employer to the reciprocal workers, which could potentially make contributions increase.

Notice also that we have constructed our hypotheses considering the constituent stage game. Since in the lab, this setting is (finitely) repeated, we cannot discard the possibility of employers choosing high offers in an attempt to signal high expectations in initial blocks, and then punishing workers in later blocks if these expectations are not met. This complementary mechanism also provides a potential rationale for the existence of a positive relationship between offers and contributions.

In these lines, we propose the following alternative hypothesis:

H_1 : Average contributions to the group project are greater when $\gamma = 3/4$ than when $\gamma = 1/2$.

We now present our hypotheses on communication. In the *Communication* treatment, the message sent by the employer is independent from the offer, γ, and non-binding for the following blocks. For instance, a positive message of *"I am grateful for high contributions"* could be followed with a low γ in the next block even if workers fully contributed. Thus, selfish workers should ignore these messages. Anticipating this, employers would be indifferent between which message to send, if any.

HC_0 : *Communication does not have an effect on workers' contributions and workers contribute zero to the group project independently of the message sent by the employer.*

Nevertheless, there is extensive literature about communication in the lab indicating that messages are indeed taken into account. For instance, previous results support the "carrot or stick" metaphor where the promise of rewards in case of cooperation work better than the threat of punishment in case on non-cooperation (see Dickinson, 2001; for an application in teamwork).

Focusing on the labour market, free communication has been shown to generate a bilateral gift exchange in the employer–employee relationship (Cooper & Lightle, 2013), specially when messages have a positive connotation (Bolton & Werner, 2016). However, according to Cason et al. (2020) expressing a desired level of effort is not enough to enhance effort, but a combination of conditional wages and promises of (ex-post) bonuses is.

In this regard, we could predict that, if subjects are not selfish, positive or expectation messages may induce greater contributions than negative or empty messages.

HC_1 : *Communication has a positive effect on workers' contributions, specially when the employer sends a positive or an expectation message.*

2.2. The experimental design and procedures

We take this game to the lab, where participants were randomly assigned the role of employer (Type A participants) and workers (Type B participants). They were also randomly assigned to groups of four, composed of one type A participant (employer, with no endowment) and three type B participants (workers, with an individual endowment $\omega = 20$ in each period). Roles and groups were fixed for the duration of the experiment. Groups were independent.

Groups played a total of 30 periods, divided in six blocks of five periods. At the beginning of each block, the group's employer chose the proportion γ between two possible offers: $\gamma = 1/2$ or $\gamma = 3/4$. Then the three workers were informed about this value and played the VCM for 5 periods with the value of γ chosen by the employer. At the end of each period, workers were informed about the group contribution, their individual payoffs and their accumulated payoffs in the block.

We opted for this block design to allow workers to experience how the structure of the social dilemma – and their payoffs – were affected by the value of γ. It is worth noting that when $\gamma = 3/4$, each of the three employees and the employer would receive an equal share of the common project, whereas when $\gamma = 1/2$ the employer retains a higher share for herself. Furthermore, notice that for the high offer to be worthwhile, employee contributions must be at least twice as high as under the low offer.

We implemented two different treatments. The *Baseline* treatment, where $M = \emptyset$, and a *Communication* treatment where, in addition, employers could send, along with their choice of γ, non-binding messages, $M = \{\text{Positive, Expectation, Negative, Empty}\}$, to their workers in the distribution stage employers. We opted for three pre-designed messages:

- "I am grateful for high contributions" (Positive)
- "I expect high contributions" (Expectation)
- "I am disappointed by low contributions" (Negative)
- "No message" (Empty)

The experiment was implemented in the Laboratory for Research in Experimental Economics (LINEEX) from the University of Valencia. We ran two sessions, one session with the *Baseline* treatment and one session with the *Communication* treatment (between-subjects design). Each session had 40 experimental subjects participating, i.e. 10 groups of 4 subjects each.[3] Each session lasted, on average 65 min, and participants earned, on average, 12 euros. A translated version of the instructions is reported in Appendix A.

3. Experimental results

In this section we present the experimental results for our experiment. We start by presenting preliminary descriptive results to have a general overview of subjects' behaviour. Next, we proceed to examine the two dimensions of our analysis: (i) the effect of the offer on contributions, and (ii) the effect of communication on contributions.

3.1. Descriptive statistics

In Table 1 we present the frequency of each offer in each treatment, along with the average contributions.

[3] Based on pilot treatments without communication, we obtained that for low offers, the average effort was 4.7629 (with standard deviation 1.6925) while for high offers, the average effort was 8.0666 (with standard deviation 3.5868). The correlation among efforts was 0.7616. With these data, a two-tails power analysis for the standard values $\alpha = 0.05$ and $1-\beta=0.8$ shows that the required sample size would be 8 for the baseline treatment. We used a conservative approach and took samples size of 10 for the baseline and the communication treatments.

Table 1
Frequency of offers and average contributions in ECUs, by offer and treatment.

	Baseline		Communication	
	Frequency	Avg. Contr.	Frequency	Avg. Contr.
Low offer ($\gamma = 1/2$)	58.33%	5.22 (2.11)	51.67%	5.55 (2.35)
High offer ($\gamma = 3/4$)	41.67%	7.88 (3.25)	48.33%	8.08 (3.69)
Total	100%	6.33	100%	6.78

Standard deviations within brackets. Ten independent observations per treatment.

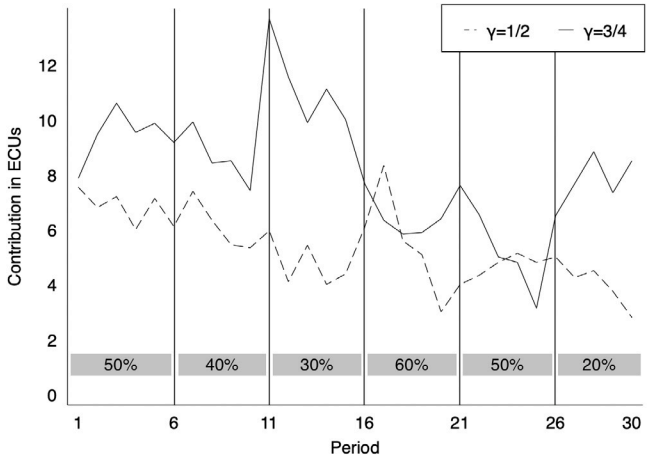

Fig. 1. Dynamics of average contributions in the *Baseline* treatment according to offer, and percentage of high offers.

We observe that average contributions are positive for both levels of offer in the two treatments, t-tests reject equality to zero contributions in all cases.[4] Moreover, contributions are significantly greater when the offer is high than when the offer is low. However, average contributions are not significantly different between the treatments.[5] In all these tests, we report two-sided p-values and use the average contribution of each group over all periods as an independent observation (10 independent observations per treatment).

In Figs. 1 and 2, we can also observe how contributions evolve over time, along with the percentage of high offers.

Average contributions display a decreasing trend, common in PGG in the lab. In some cases, a slight restart effect at the beginning of each block (periods 1, 6, 11, 16, 21 and 26) can be observed. In the *Baseline* treatment, contributions are greater under high offers than under low offers for most of the rounds, except between the fourth and the fifth block. In the last block, contributions diverge. Something similar can be observed in the *Communication* treatment, where contributions under $\gamma = 1/2$ are only higher than contributions under $\gamma = 3/4$ in the fourth block. In the latter treatment, contributions display a greater volatility, possibly due to the different dynamics that different messages sent generate.

[4] Two sided t-tests that compare average contributions to zero: $t = 7.8774$, p-value = 0.000, $N = 10$ for Low offer in *Baseline*; $t = 6.4403$, p-value = 0.000, $N = 10$ for High offer in *Baseline*; $t = 7.2946$, p-value = 0.000, $N = 10$ for Low offer in *Communication*; and $t = 7.0392$, p-value=0.0002, $N = 10$ for High offer in *Communication*.

[5] Two-sided Wilcoxon signed-rank test for paired samples which compares average contributions under low and high offers, $z = -2.395$, p-value = 0.016, $N = 10$ for *Baseline*; and $z = -2.666$, p-value = 0.008, $N = 9$ for *Communication* since one group always had low offers. Two-sided Mann–Whitney-Wilcoxon tests of equal average contributions between treatments *Baseline* and *Communication*, $z = 0.680$, p-value = 0.496, $N = 20$ for Low offer; $z = -0653$, p-value = 0.514, $N = 19$ for High offer.

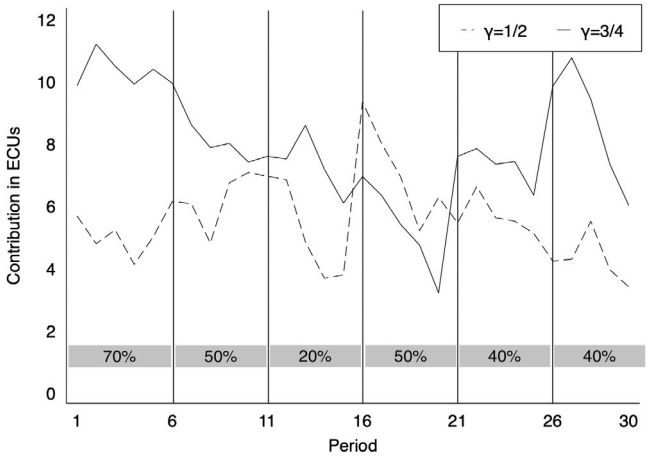

Fig. 2. Dynamics of average contributions in the *Communication* treatment according to offer, and percentage of high offers.

Table 2
Frequency of messages and average contributions in ECUs in the *Communication* treatment.

	Frequency	Low offer ($\gamma = 1/2$)	High offer ($\gamma = 3/4$)	Avg. Contribution
Positive	26.67%	25%	75%	7.95
Expectation	23.33%	57.14%	42.86%	7.13
Negative	26.67%	75%	25%	6.18
Empty	23.33%	50%	50%	5.76

Finally, Table 2 presents the frequency with which each message was sent in the *Communication* treatment, the frequency of low and high offers, and the average contributions in each case.

All types of messages were roughly equally offered, but there was a strong correlation between positive messages and high offers, and between negative messages and low offers.

3.2. What is the effect of the offer on contributions?

To test the effect of the offer that the employer makes on workers' contributions, we propose two random-effects panel data models using Generalized Least Squares clustered at the group level in Table 3. In the regression analysis in this paper, all stars refer to two-sided p-values.

In these models, the dependent variable is the contribution and the explanatory variables are: whether the offer is high (dummy variable *High Offer* takes value 1 when $\gamma = 3/4$ in that block and takes value 0 when $\gamma = 1/2$ in that block); whether we are in the Communication treatment (dummy variable *Communication* takes value 1 in this treatment and value 0 in the *Baseline* treatment); the interaction between *High Offer* and *Communication* (dummy *High Offer* × *Communication* takes value 1 when $\gamma = 3/4$ in the *Communication* treatment and 0 otherwise); a time variable indicating the period (*Period*)[6]; the individual's previous contribution (*Previous Contribution*); the previous group contribution excluding the individual's contribution (*Previous group contribution*$_{-i}$); and whether the offer in the previous block was high (dummy variable *Previous high offer* takes value 1 if in the previous block $\gamma = 3/4$ and 0 if in the previous block $\gamma = 1/2$).

[6] We also run complementary regressions including alternative time variables such as the block (from 1 to 6), the subperiod within the block (from 1 to 5), interaction between period and communication and between communication and offer. These alternatives do not vary the results qualitatively.

Table 3
Panel data linear model with random effects clustered at the group level, explaining workers' contributions.

	(1) Contribution	(2) Contribution
Constant	6.9305***	1.9457***
	(0.7203)	(0.3065)
High Offer	2.2831***	1.0921***
	(0.7741)	(0.3274)
Communication	−0.2822	0.1839
	(1.0126)	(0.3409)
High Offer × Communication	1.1932	−0.1726
	(1.1705)	(0.7973)
Period	−0.1002***	−0.0276**
	(0.0260)	(0.0121)
Previous contribution		0.5764***
		(0.0524)
Previous group contribution$_{-i}$		0.0490
		(0.0320)
Previous high offer		−0.1515
		(0.3544)
Number of observations	1800	1500
Number of clusters	20	20

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 4
Panel data linear model with random effects clustered at the group level, explaining workers' contributions disaggregating communication.

	(1) Contribution	(2) Contribution
Constant	7.0407***	2.0987***
	(0.7293)	(0.3284)
High Offer	2.2712***	1.1127***
	(0.7629)	(0.3297)
Positive	−0.8385	1.0886**
	(0.8853)	(0.4636)
Negative	0.2900	0.4153
	(1.1527)	(0.3338)
Expectation	−0.7948	0.2401
	(1.5723)	(0.7817)
Empty	−0.4580	−0.4755
	(0.8897)	(0.3318)
Positive × High Offer	1.4899	−1.0551
	(1.2435)	(1.0163)
Negative × High Offer	0.9333	−0.1727
	(2.3824)	(1.4812)
Expectation × High Offer	2.5835	−0.0363
	(1.6239)	(1.1467)
Empty × High Offer	0.9882	0.0966
	(0.9834)	(0.6759)
Period	−0.1070***	−0.0345**
	(0.0269)	(0.0135)
Previous contribution		0.5731***
		(0.0524)
Previous group contribution$_{-i}$		0.0457
		(0.0321)
Previous high offer		−0.0989
		(0.3713)
Number of observations	1800	1500
Number of clusters	20	20

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

While Model 1 focuses on the offer, the treatment and its interaction, in Model 2, we add the three lagged variables: the previous own contribution, the previous group contribution (excluding own contribution) and the previous offer. Both models include the time variable, *Period*.[7]

When employers give high offers, $\gamma = 3/4$, contributions are significantly greater than when employers give low offers, $\gamma = 1/2$. This result is robust when controlling for past behaviour in Model 2. In fact, the margin of the coefficient of *High Offer* in Model 1 is 2.8797 (p-value=0.000) and in Model 2 is 1.0058 (p-value=0.014). Thus, we reject our first null hypothesis that claimed that the offer has no impact on contributions and we do not reject our alternative behavioural hypothesis.

Result 1. *When the employer gives high offers, workers contribute more than when the employer gives them low offers.*

Moreover, there is a decreasing trend in contributions, that is, as time goes by, contributions fall. Nevertheless, the chance to communicate or receiving high offers in the communication treatment seem to have no direct significant impact on contributions. Concerning past behaviour, the previous contribution has a positive significant effect on present contributions. However, the previous group contribution or the previous offer do not.

To further explore the positive effects of high offers, in Table 6 in Appendix B we report alternative specifications to Models 1 and 2 of Table 3, using the variation in contributions as the dependent variable (following the approach of Smith, 2015).[8] We find that the results remain robust under these specifications.

Finally, since the game is repeated, we explore the possibility that some employers signal an expectation of high contributions by making a high offer in the initial block, and subsequently punish (reward) workers in later blocks if their contributions are low (high).[9] To investigate this hypothesis, we analyse those groups that received a high offer in the initial block. For these five groups, we find a positive correlation between the average contribution in the first block and the frequency of high offers by employers in subsequent blocks, i.e., an effect in the expected direction, although it is not significant (0.1586, p-value = 0.7989).

3.3. What is the effect of communication on contributions?

Despite the possibility of communicating does not have an impact on contributions *per se*, the specific messages sent in the *Communication* treatment could. With this end, we present two random-effects panel data models using Generalized Least Squares clustered at the group level in Table 4.

In these models, the dependent variable is the contribution and the explanatory variables are the ones of Table 3, but instead of introducing the variable *Communication*, we substitute it by 4 dummy variables, one for each message (*Positive, Negative, Expectation, Empty*),[10] and their interaction with the variable *High offer* (*Positive* × *High Offer, Negative* × *High Offer, Expectation* × *High Offer, Empty* × *High Offer*).

Following the same structure as in Table 3, Model 1 focuses on the impact of the offer, the treatment and its interaction, while Model 2 we introduce the lagged variables collecting previous behaviour. Both models include the time variable.

The results show that only the positive message is significant in explaining contributions, and only in Model 2. Furthermore, its impact is positive. That is, receiving a positive message significantly increases contributions only if we control for previous behaviour, i.e. previous contribution, previous group contribution and previous offer. Using

[7] Note that when we introduce the variable *Previous offer*, we discard the first block of the experiment, as there is no previous offer in this block. Thus, there is a lower number of observations in Model 2.

[8] Other works that also use a similar approach are Bigoni and Suetens (2012), Huck et al. (1999) and Alventosa et al. (2021).

[9] To this end, we focus on the *Baseline* treatment, since in the *Communication* treatment messages could also serve as a channel to convey employers' expectations.

[10] Recall that there were 4 possible message types: *Positive*, *Negative*, *Expectation*, *Empty* and the base is no communication at all (*Baseline* treatment). Thus, results are interpreted with respect to the *Baseline* treatment.

Table 5
Panel data logit model with random effects explaining employers' offers.

	(1) Pr(High Offer)	(2) Pr(High Offer)
Constant	−0.0258	0.7243
	(0.4967)	(0.9701)
Positive	1.3907**	1.9407**
	(0.6696)	(0.9812)
Negative	-0.6880	−0.6647
	(0.6716)	(0.6991)
Expectation	0.0521	0.2164
	(0.6349)	(0.7142)
Empty	0.3371	−0.0195
	(0.6320)	(0.7286)
Block	-0.0920	−0.1733
	(0.1174)	(0.1715)
Previous group contribution		−0.032
		(0.0214)
Previous high offer		0.2373
		(0.5226)
Number of observations	120	100

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Wald tests, we find that the coefficient for *Positive* is significantly greater than the coefficient for *Negative* (at the 5% level) and than the coefficient for *Empty* (at the 10% level). However, there is no statistical difference between any other pair of message coefficients.[11]

We analyse the impact of the positive message a little bit further by obtaining the margin of this variable for the different offers. The margin of the coefficient of *Positive* in Model 2 is 1.089 (p-value=0.019) if the offer is low ($\gamma = 1/2$) and 0.0335 (p-value=0.969) if the offer is high (γ=3/4). Hence, the positive message has a significantly positive effect only when the offer is low. Therefore, we reject the null hypothesis on communication that claimed that communication was completely irrelevant on contributions, and we partially accept the alternative behavioural hypothesis.

Result 2. *Positive messages have a direct positive impact on contributions when the offer is low. When the employer sends a positive message, the workers' contributions are greater than when the employer sends no message at all.*

Noticing the strong impact that the offer has on contributions, we finally analyse the probability that the employer makes a high offer. To this end, we propose two random-effects logit models in Table 5.[12]

In these models, the dependent variable is the probability of the employer making high offers ($\gamma = 3/4$) and the explanatory variables are: the type of message (dummy variables *Positive*, *Negative*, *Expectation* and *Empty*; a time variable indicating the block (*Block*); the previous group contribution (*Previous group contribution*); and whether the offer in the previous block was high (dummy variable *Previous high offer* taking value 1 if in the previous block $\gamma = 3/4$ and 0 otherwise). In this case, we restrict the analysis to the first period of each block because we analyse offers, which are only made in the first period of the block.

We find that the only message that has a significant coefficient in the regression is the positive one. This suggests that, for employers, sending the message *"I am grateful for high contributions"* is positively correlated with making a high offer.[13] In particular, the marginal effect of the coefficient for *Positive* in Model 1 is 0.3161 (p-value=0.018) and in Model 2 it is 0.4024 (p-value=0.007), which implies that when the positive message is sent, the probability of high offers is, approximately, 30%–40% higher with respect to the case without communication.[14]

Recall that a positive message has a direct positive impact on contributions. We now also find that there is a positive correlation between positive messages and high offers on the side of employers, which may well reflect that there is a type of employer that sends positive messages and offers a high share of the return of the common project. Moreover, according to Result 1, under high offers workers contribute more.

Result 3. *Positive messages are positively correlated with high offers, which in turn, increase contributions.*

4. Conclusions

In this paper we have experimentally studied whether reciprocity and communication are effective to meliorate social dilemmas in the firm. Our results suggest that there is a "gift-exchange" between employers and workers, since high offers by the former ones induce higher contributions by the later ones, even if they have incentives to free-ride on others. Communication seems to help in this "gift-exchange", although not all messages have the same effect. We find that messages with a positive (gratitude) content by the employers have an effect on the workers choices (raising their contribution), and are also correlated with higher offers on the side of the employers. However, messages with negative (disappointment) connotations or expressing the employers expectations do not seem to be effective.

Our results have direct implications for firms that aim to provide the proper incentives to their workers. When workers' wages are linked to the firm income, providing them with a sufficiently high share of it can be effective to activate high efforts, thus, subsequently increasing the employer's payoff. Moreover, when designing a communication strategy on the side of the employer, not all messages are useful to enforce high efforts. In this case, messages including positive (gratitude) connotations can trigger reciprocity concerns and better align the workers' incentives to those of the firm.

Thus, our results suggest that when there exist social dilemma problems derived from team production in a firm, it may be beneficial for employers to offer "efficiency wages" to their employees in order to trigger reciprocity on their side. Also, when designing an effective communication strategy, it is advisable for employers to focus on messages that express positive concerns, like gratitude.

In any case, we believe that this paper is just a first step in a broad research agenda that explores the links between gift-exchange, public goods games and communication. For example, among other interesting aspects of the problem at hand, further research can study the effects of cheap-talk communication (like, e.g., promises) on the side of employees, or also two-way free-form (chat) communication. Following Stoddard et al. (2021), it would also be interesting to investigate the case of flexible offers, where the allocator distributes to group members a flexible share of the group fund between 0 and 100%. Finally, it would also merit investigation to compare a scenario without

[11] See Table 7 in Appendix B for alternative specifications to Models 1 and 2 of Table 4, using the variation in contributions as the dependent variable, with robust results.

[12] Note that for all models in Tables 3–7, we have used random effects in order to be able to capture treatment effects. Hausman tests show that random effects are consistent in models 1 of Tables 3–7 and in models 2 of Tables 5–7.

[13] Table 8 in the Appendix reports the distribution of messages accompanying high and low offers by group in the Communication Treatment. Despite some heterogeneity across groups, we observe that for high offers, only in 20% of the groups the modal message is the expectation or the negative one. For the remaining 80% of the groups, the positive – or the empty message – is modal. For low offers, the modal message is the negative one in 70% of the groups.

[14] If we examine whether the differences between the coefficients of the different types of messages are significant, we find that only the difference between *Positive* and *Negative* is significant (p-value=0.015 in Model 1 and p-value=0.018 in Model 2).

Table 6
Panel data linear model with random effects clustered at the group level, explaining workers' increase in contributions.

	(1) Variation in Contr.	(2) Variation in Contr.
Constant	−0.2923**	−0.0801
	(0.1129)	(0.2628)
High Offer	0.4836**	0.5002**
	(0.2408)	(0.2352)
Communication	−0.0444	−0.03161
	(0.1832)	(0.1785)
High Offer × Communication	0.0013	0.1004
	(0.4499)	(0.4234)
Period	−0.0024	0.0006
	(0.0053)	(0.0081)
Previous group contribution$_{-i}$		−0.0173
		(0.0154)
Previous high offer		−0.2178
		(0.2213)
Number observations	1740	1500
Number clusters	60	60

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 7
Panel data linear model with random effects clustered at the group level, explaining workers' increase in contributions disaggregating communication.

	(1) Variation in Contr.	(2) Variation in Contr.
Constant	−0.2634**	−0.0433
	(0.1191)	(0.3070)
High Offer	0.4811**	0.5038**
	(0.2412)	(0.2379)
Positive	0.0814	0.4054**
	(0.3374)	(0.1870)
Negative	0.0547	0.0863
	(0.2021)	(0.1802)
Expectation	−0.0075	−0.0933
	(0.3044)	(0.3583)
Empty	−0.3156	−0.2785
	(0.4587)	(0.4264)
Positive × High Offer	−0.2306	−0.4341
	(0.5147)	(0.4090)
Negative × High Offer	0.3463	0.3720
	(0.6116)	(0.6027)
Expectation × High Offer	−0.4090	−0.0121
	(0.5214)	(0.6061)
Empty × High Offer	0.4980	0.3160
	(0.6335)	(0.4874)
Period	−0.0041	−0.0021
	(0.0058)	(0.0091)
Previous group contribution$_{-i}$		−0.0179
		(0.0169)
Previous high offer		−0.1830
		(0.2078)
Number observations	1740	1500
Number clusters	20	20

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

allocator, in which workers equally distribute the public output among themselves, and a scenario in which there is a non-productive allocator, which takes rents but can activate high (reciprocal) contributions by means of high offers. Such a comparison can yield a rationale for the existence of managers in terms of efficiency.

CRediT authorship contribution statement

Marta Ruiz-Delgado: Project administration, Data curation. **Adriana Alventosa:** Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Miguel A. Meléndez-Jiménez:** Writing – original draft, Supervision, Resources, Methodology, Investigation, Conceptualization. **Antonio J. Morales:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

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Appendix A. Instructions

Instructions for the Baseline treatment. Between square brackets [ ] additions made in the Communication treatment.

Welcome and thank you for participating in this experiment. Please, read these instructions carefully. During the experiment, you will have the opportunity of earning money. How much money you earn depends on your decisions and the decisions made by other participants during the experiment. All payments will be expressed in ECUs (Experimental Currency Unit), will be exchanged to Euros at the end of the experiment and will be given to you in a sealed envelope. Any communication between you is expressly forbidden and subject to immediate expulsion from the experiment. In case of having any doubt, please raise your hand. Doubts will be solved privately.

The Experiment

At the beginning of this experiment, you will be randomly assorted into groups of 4 participants. Within each group, 1 participant will be randomly assigned the **Type A** role and the other 3 participants will be randomly assigned the **Type B** role. Both groups and roles will be fixed during the whole experiment.

You will play 6 blocks with 5 rounds each one.

- What decisions does each type make?

In each round, each Type B participant of the group will receive an endowment of 20 ECUs and will decide how many of these ECUs to contribute to a common project (c) and how many ECUs to keep for himself/herself ($20 - c$).

The return of the common project (R) will be the sum of the contributions of the 3 Type B participants multiplied by 2.

Return of the common project (R) = 2·*(Sum of the contributions of Type B participants)*

The Type A participant, who does not receive an initial endowment, must decide how to distribute the return of the common project between him/her and the 3 Type B participants. To do so, he/she will choose which proportion of R to allocate to the Type B participants (p) and which proportion to keep for himself/herself ($1 - p$). The Type A participant will have two options about how much to allocate to Type B participants: $p = 0.5$ or $p = 0.75$.

The proportion allocated to Type B participants will be equally shared among the 3. That is, each Type B participant will receive $p/3$ of the return of the common project.

- If the Type A participant chooses $p = 0.5$, Type B participants receive 50% of the return of the common project, which will be equally shared among the 3 participants. The Type A participant will keep the remaining 50%.
- If the Type A participant chooses $p = 0.75$, Type B participants receive 75% of the return of the common project, which will be equally shared among the 3 participants. The Type A participant will keep the remaining 25%.

Table 8
Percentages of offers and messages by group in the Communication Treatment.

Group	% High Offers	Message accompanying high offer (%)				Message accompanying low offer (%)			
		Positive	Expectation	Negative	Empty	Positive	Expectation	Negative	Empty
1	0	–	–	–	–	0	50	50	0
2	50	0	0	0	100	33.33	33.33	33.33	0
3	66.67	50	25	25	0	0	0	50	50
4	33.33	100	0	0	0	25	25	50	0
5	50	33.33	66.67	0	0	0	0	66.67	33.33
6	66.67	25	0	0	75	50	0	0	50
7	83.33	60	20	20	0	0	100	0	0
8	33.33	100	0	0	0	0	0	50	50
9	83.33	20	40	40	0	0	0	0	100
10	16.67	0	0	0	100	20	40	20	20

Therefore, the payoff for the Type A participant will be the proportion of the return of the common project that he/she has decided to keep for himself/herself:

Payoff of Type A participant: $(1-p)\cdot R$

For each Type B participant, his/her payoff will be the amount of ECUs that he/she has decided to keep for himself/herself, $20-c$, plus the proportion of the return of the common project that the Type A participant has decided to allocate to him/her, $\frac{p}{3}\cdot R$:

Payoff of Type B participant: $20-c+\frac{p}{3}R$

- When are decisions made?

The experiment is divided into 6 blocks of 5 rounds each.

At the beginning of each block, the Type A participant will choose the proportion of return of the common project to allocate to the Type B participants during the whole block: $p=0.5$ or $p=0.75$.

[*Communication:* Then, the Type A participant will be able to send a message to the Type B participants in his/her group. Once the share of the return of the common project has been decided, a list of predefined messages will appear, from which he/she will be able to choose one for the three Type B participants. He/she will also be able to choose not to send any message.]

Next, Type B participants will observe the share chosen by the Type A participant for that block [*Communication:* along with the message sent by the Type A participant].

In each of the 5 rounds of each block, Type B participants will simultaneously decide how much to contribute to the common project, c. In each round, the share will be done according to the decision that the Type A participant made at the beginning of the block.

At the end of each round, all participants will observe the sum of the contributions made to the common project, their own payoff for that round and the accumulated payoff in the block until that round.

While participants of one type are making a decision, participants of the other type will be asked to answer some questions that they will observe on their screen.

- How is the final payment determined?

At the end of the experiment, one of the 6 blocks will be randomly chosen. Your final payment will be the sum of the earnings in ECUs made in that block converted to Euros according to the following ratio:

10 ECUs = 1 €

The minimum payment will be of 5 €.

Appendix B. Additional analysis

In this appendix, we first present alternative specifications for Tables 3 and 4, where the dependent variable is the variation in contributions rather than the contributed amount in a given period, in line with Smith (2015). Our results remain robust, with the significance and direction of the estimated coefficients unchanged, except for the time variable *period*, which becomes non-significant.

Data availability

Data will be made available on request.

References

Akerlof, G. A. (1982). Labor contracts as partial gift exchange. *The Quarterly Journal of Economics*, *97*(4), 543–569.

Akerlof, G. A., & Yellen, J. L. (1990). The fair wage-effort hypothesis and unemployment. *The Quarterly Journal of Economics*, *105*(2), 255–283.

Alventosa, A., Antonioni, A., & Hernández, P. (2021). Pool punishment in public goods games: How do sanctioners' incentives affect us? *Journal of Economic Behavior and Organization*, *185*, 513–537.

Bigoni, M., & Suetens, S. (2012). Feedback and dynamics in public good experiments. *Journal of Economic Behavior and Organization*, *82*(1), 86–95.

Bolton, G., & Werner, P. (2016). The influence of potential on wages and effort. *Experimental Economics*, *19*, 535–561.

Brandts, J., & Charness, G. (2004). Do labour market conditions affect gift exchange? Some experimental evidence. *The Economic Journal*, *114*(497), 684–708.

Brandts, J., & Cooper, D. J. (2007). It's what you say, not what you pay: An experimental study of manager-employee relationships in overcoming coordination failure. *Journal of the European Economic Association*, *5*(6), 1223–1268.

Cason, T. N., Friesen, L., & Gangadharan, L. (2020). Inter-firm social dilemmas with agency risk. *European Economic Review*, *129*, Article 103570.

Cason, T. N., Friesen, L., & Gangadharan, L. (2025). Communication, guilt, and agency risk with payoff externalities. (Mimeo).

Charness, G., & Dufwenberg, M. (2006). Promises and partnership. *Econometrica*, *74*(6), 1579–1601.

Cooper, D. J., & Lightle, J. P. (2013). The gift of advice: Communication in a bilateral gift exchange game. *Experimental Economics*, *16*, 443–477.

Cox, C. A., & Stoddard, B. (2024). Inequality and the allocation of collective goods. *Journal of Economic Behavior and Organization*, *220*, 756–767.

Croson, R., Fatas, E., Neugebauer, T., & Morales, A. J. (2015). Excludability: A laboratory study on forced ranking in team production. *Journal of Economic Behavior and Organization*, *114*, 13–26.

Croson, R., & Konow, J. (2009). Social preferences and moral biases. *Journal of Economic Behavior and Organization*, *69*(3), 201–212.

Dickinson, D. L. (2001). The carrot vs. the stick in work team motivation. *Experimental Economics*, *4*, 107–124.

Drouvelis, M., Nosenzo, D., & Sefton, M. (2017). Team incentives and leadership. *Journal of Economic Psychology*, *62*, 173–185.

Englmaier, F., Strasser, S., & Winter, J. (2014). Worker characteristics and wage differentials: Evidence from a gift-exchange experiment. *Journal of Economic Behavior and Organization*, *97*, 185–203.

Faillo, M., Grieco, D., & Zarri, L. (2013). Legitimate punishment, feedback, and the enforcement of cooperation. *Games and Economic Behavior*, *77*(1), 271–283.

Falk, A., & Kosfeld, M. (2006). The hidden costs of control. *American Economic Review*, *96*(5), 1611–1630.

Fehr, E., & Gächter, S. (2000). Cooperation and punishment in public goods experiments. *American Economic Review*, *90*(4), 980–994.

Fehr, E., Gächter, S., & Kirchsteiger, G. (1997). Reciprocity as a contract enforcement device: Experimental evidence. *Econometrica: Journal of the Econometric Society*, *83*, 3–860.

Fehr, E., Kirchler, E., Weichbold, A., & Gächter, S. (1998). When social norms overpower competition: Gift exchange in experimental labor markets. *Journal of Labor Economics*, *16*(2), 324–351.

Gächter, S., & Falk, A. (2002). Reputation and reciprocity: Consequences for the labour relation. *ScandInavian Journal of Economics*, *104*(1), 1–26.

Gneezy, U., & List, J. A. (2006). Putting behavioral economics to work: Testing for gift exchange in labor markets using field experiments. *Econometrica*, *74*(5), 1365–1384.

Hannan, R. L., Kagel, J. H., & Moser, D. V. (2002). Partial gift exchange in an experimental labor market: Impact of subject population differences, productivity differences, and effort requests on behavior. *Journal of Labor Economics*, *20*(4), 923–951.

Haruvy, E., Li, S. X., McCabe, K., & Twieg, P. (2017). Communication and visibility in public goods provision. *Games and Economic Behavior*, *105*, 276–296.

Holmström, B. (1982). Moral hazard in teams. *Bell Journal of Economics*, *32*, 4–340.

Huck, S., Normann, H. T., & Oechssler, J. (1999). Learning in cournot oligopoly–an experiment. *The Economic Journal*, *109*(454), 80–95.

Isaac, R. M., & Walker, J. M. (1988). Group size effects in public goods provision: The voluntary contributions mechanism. *The Quarterly Journal of Economics*, *103*(1), 179–199.

Karakostas, A., Kocher, M. G., Matzat, D., Rau, H. A., & Riewe, G. (2023). The team allocator game: Allocation power in public goods games. *Games and Economic Behavior*, *140*, 73–87.

Kosfeld, M., Okada, A., & Riedl, A. (2009). Institution formation in public goods games. *American Economic Review*, *99*(4), 1335–1355.

Kube, S., Maréchal, M. A., & Puppe, C. (2012). The currency of reciprocity: Gift exchange in the workplace. *American Economic Review*, *102*(4), 1644–1662.

Mirrlees, J. A. (1999). The theory of moral hazard and unobservable behaviour: Part i. *Review of Economic Studies*, *66*(1), 3–21.

Nikiforakis, N. (2010). Feedback, punishment and cooperation in public good experiments. *Games and Economic Behavior*, *68*(2), 689–702.

Smith, A. (2015). Contribution heterogeneity and the dynamics of contributions in repeated public good games. *Journal of Behavioral and Experimental Economics*, *58*, 149–157.

Stoddard, B. V., Caleb, A. C., & J.M., Walker (2021). Incentivizing provision of collective goods: Allocation rules. *Southern Economic Journal*, *87*(4), 1345–1365.

Stoddard, B., Walker, J. M., & Williams, A. (2014). Allocating a voluntarily provided common-property resource: An experimental examination. *Journal of Economic Behavior and Organization*, *101*, 141–155.

Traulsen, A., Röhl, T., & Milinski, M. (2012). An economic experiment reveals that humans prefer pool punishment to maintain the commons. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1743), 3716–3721.

Van der Heijden, E., Potters, J., & Sefton, M. (2009). Hierarchy and opportunism in teams. *Journal of Economic Behavior and Organization*, *69*(1), 39–50.