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## The effects of (incentivized) belief elicitation in public goods experiments

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CENTRE FOR DECISION RESEARCH & EXPERIMENTAL ECONOMICS



The University of  
Nottingham

Discussion Paper No. 2010-12

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and  
Elke Renner  
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The Effects of (Incentivized)  
Belief Elicitation in Public  
Goods Experiments

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# The effects of (incentivized) belief elicitation in public goods experiments

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**Abstract** Belief elicitation is an important methodological issue for experimental economists. There are two generic questions: 1) Do incentives increase belief accuracy? 2) Are there interaction effects of beliefs and decisions? We investigate these questions in the case of finitely repeated public goods experiments. We find that belief accuracy is significantly higher when beliefs are incentivized. The relationship between contributions and beliefs is slightly steeper under incentives. However, we find that incentivized beliefs tend to lead to higher contribution levels than either non-incentivized beliefs or no beliefs at all. We discuss the implications of our results for the design of public good experiments.

**Keywords:** Incentives, beliefs, experimental methodology, public goods.

**JEL Classification Codes:** C 90

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## 1. Introduction

Beliefs, like preferences and constraints, are a central concept in modern economics. Eliciting beliefs about co-players' behavior is therefore often interesting for experimental economists. Yet, when eliciting beliefs one important design question is: should subjects be financially rewarded if their stated beliefs about their opponents' choices correspond to their opponents' actual choices? Compared to a rather voluminous literature on the importance of financial incentives for making *choices*<sup>1</sup>, the corresponding literature for elicited *beliefs* is still rather scant.<sup>2</sup> This paper contributes to the literature on the role of incentives in belief elicitation.

From an experimental design point of view the question whether beliefs should be incentivized is less straightforward than whether choices should be incentivized. The reason is that there are two generic issues when beliefs are elicited. The first one is whether incentives improve results in the sense that they actually increase the accuracy of elicited beliefs and the second issue concerns possible interaction effects of (incentivized) beliefs with other variables of interest. This paper addresses both generic issues in the context of public goods experiments. We believe empirical knowledge on the role of (incentivized) beliefs in public goods experiments is important because eliciting beliefs about other group members' contributions has long been of interest to researchers.<sup>3</sup>

With regard to the first generic question our goal is not to assess different methods of incentivizing belief elicitation<sup>4</sup>, but to see whether with a given method of belief elicitation

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<sup>1</sup> Camerer and Hogarth (1999) review the literature and conduct a meta-analysis (comprising 74 studies) about the impact of financial incentives for choices. For an earlier survey see Smith and Walker (1993). Hertwig and Ortmann (2001) compare practices of using incentives in psychology and economics.

<sup>2</sup> Some examples of studies relevant to ours are the following. Wright and Aboul-Ezz (1988) investigate the impact of incentives on the quality of frequency assessments and find that incentives increase accuracy. Erev, et al. (1993) find that eliciting probability assessments can interact with other variables of interest in public goods games. Similarly, Croson (1999) and Croson (2000) look at prisoner's dilemma and public goods games and find that eliciting beliefs changes contributions compared to when beliefs are not elicited. Rutström and Wilcox (2009) look at matching pennies games and find that eliciting beliefs can change play.

<sup>3</sup> See Kelley and Stahelski (1970) and Kuhlman and Wimberley (1976) for early studies in psychology. In experimental economics, Offerman (1997), and Offerman, et al. (1996) were among the first to elicit beliefs to understand behavior in step-level public goods. Dufwenberg, et al. (2006) elicited beliefs in one-shot games to investigate the impact of framing and to evaluate theories of reciprocity and guilt aversion. Croson (2007) elicited beliefs in repeatedly played public goods games to test theories of voluntary cooperation. Gächter and Herrmann (2009) elicited beliefs to understand cross-cultural differences in cooperation behavior. Neugebauer, et al. (2009) and Fischbacher and Gächter (2010) elicited beliefs to explain the declining pattern of cooperation in repeated public good games.

<sup>4</sup> On this question see, e.g., Holt (1986); Selten (1998); Andersen, et al. (2007); Offerman, et al. (2009); Palfrey and Wang (2009).

incentivizing beliefs affects the accuracy of stated beliefs. The second question is whether there are interaction effects of (incentivized) beliefs with contribution decisions. For instance, incentives for beliefs might change the *relationship* between beliefs and contributions (the focus of much research – see footnote 3) and the mere fact that beliefs are elicited at all might also affect overall contribution *levels*. For example, Croson (2000) found significantly *lower* contribution rates in her finitely repeated public goods experiments when she elicited incentivized beliefs than when she did not elicit beliefs. Steep incentives for accurate beliefs might help belief accuracy but might also change the whole incentive structure of the experiment (Blanco, et al. (2010)).

We answer our research questions with the help of three treatments: (i) a benchmark treatment where we did not elicit beliefs (called the “no beliefs treatment”); (ii) a “non-incentivized beliefs treatment” where we simply asked subjects about their estimated average contributions of other group members; and (iii) an “incentivized beliefs treatment” where subjects were paid according to the accuracy of their estimates relative to the actual average contribution of other group members.

We find that incentivizing beliefs significantly increases belief accuracy. With regard to interaction effects of belief elicitation and contributions we find that the *relationship* between beliefs and contributions is slightly stronger when beliefs are incentivized. We also find that incentivized beliefs might affect contribution *levels*: In our experiments contributions are significantly *higher* (in particular in the second half of the experiment) when elicited beliefs are incentivized but insignificantly different when beliefs are elicited but not incentivized.

Notice that the goal of this paper is not to test particular theories why beliefs and contributions might be correlated, or why beliefs might affect contribution levels. Our contribution is a basic methodological one: highlighting any tradeoff that might exist between incentivizing beliefs and possible interaction effects with contribution choices. We discuss the potential implications of our findings for designing experiments in our concluding section.

## **2. Design and procedures**

Our design involves a standard linear public goods game, played by groups of four members. Each member has to decide on how many of 20 tokens to keep and how many tokens to contribute to a public good. The stage game payoff for each subject is given by:

$$\pi_i = 20 - g_i + 0.4 \sum_{j=1}^4 g_j . \quad (1)$$

From (1) it is obvious that a rational and selfish individual has an incentive to contribute nothing, whereas full contributions would be socially optimal.

We had three treatments in two of which we elicited beliefs about the other group members' average contribution. Specifically, on the same screen we prompted subjects for contribution decisions, we also prompted them for estimates how much the other three group members will contribute on average to the public good (see the instructions in the online supplementary materials for details).<sup>5</sup> In one treatment (“incentivized beliefs”) we gave them a financial incentive for reporting beliefs accurately. We paid subjects 20 money units in every case where a participant estimated the actual contribution of others exactly right ( $\pm 0.5$  tokens); and 10 money units divided by the (absolute) estimation error if his or her estimate deviated by more than  $\pm 0.5$  tokens from the actual contribution. In a second treatment we simply elicited beliefs without any payment for accuracy of belief estimation (“non-incentivized beliefs”). Since belief elicitation itself may change contribution behavior, we included a benchmark treatment (“no beliefs”) in which we did not elicit beliefs.

We conducted all experiments at the Universities of Erfurt and Nottingham.<sup>6</sup> We used z-Tree (Fischbacher (2007)) to conduct the experiments. Our participants were 204 undergraduates from various disciplines; 72 people participated in the “no beliefs” treatment; 68 in the “non-incentivized beliefs” treatment and 64 in the “incentivized beliefs” treatment. We allocated participants to groups randomly, but group composition remained the same throughout the ten periods of the experiment (“partners”). Thus, in total we have observations from 51 independent groups of four participants.

The participants were randomly assigned to the booths in the laboratory at the beginning of each session. The booths separated the participants visually and ensured that every individual made his or her decision anonymously and independently. The written instructions explained the game, payoffs, and procedures. Participants had to answer a set of control questions and we did not start before all participants had answered all questions correctly. In all treatments participants received their cumulative earnings according to (1). In the

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<sup>5</sup> Since we asked participants to estimate the average contribution of the *other three* group members, participants had no strategic incentives to manipulate the accuracy of their estimate by changing their own contribution.

<sup>6</sup> We used ORSEE (Greiner (2004)) for recruiting participants.

incentivized beliefs treatment earnings also included the belief estimation payoffs. Our experiments lasted 30 minutes on average, and participants earned € 4.50 in Erfurt and £ 7.70 in Nottingham (these are very similar amounts in terms of purchasing power). Earnings exceed the average hourly wage of a typical student job in both locations.

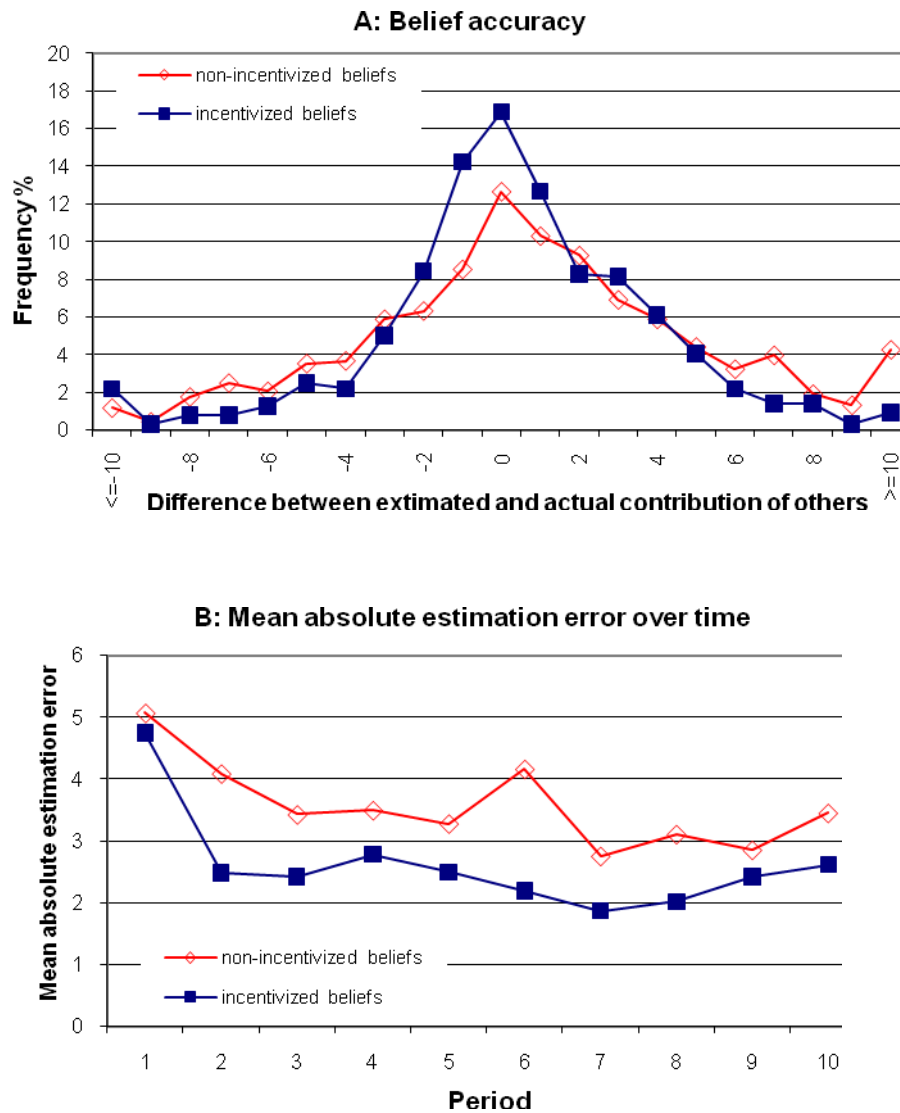
### 3. Results

*Result 1.* Belief accuracy (the difference between stated beliefs and actual contributions) is significantly higher when belief elicitation is incentivized than under non-incentivized belief elicitation.

*Support.* A first support for Result 1 is Figure 1. Panel A shows the distribution of the difference between estimated and actual contributions of other group members. In both treatments there is a mode at zero, that is, perfect belief accuracy. The frequency of exactly correct beliefs is 13 percent under non-incentivized beliefs and 17 percent under incentivized beliefs. When beliefs are not incentivized, 32 percent (47 percent) of beliefs differ by  $\pm 1$  ( $\pm 2$ ) from others' actual contributions; this ratio is 44 percent (61 percent) under incentivized belief elicitation. The mean (median) difference is 0.90 (0.67) under non-incentivized beliefs and 0.31 (0.00) under incentivized beliefs. The standard deviation of the differences across all decisions is 4.75 under non-incentivized beliefs and 3.68 under incentivized beliefs.

Panel B of Figure 1 depicts the development of the mean absolute estimation error over time. We also use this statistic for statistical testing since we are interested in any error – positive and negative. In the following we report test results based on two-sided non-parametric tests with group averages as independent observations.





**Fig. 1** Belief accuracy: Distribution (panel A) and development over time (panel B).

We get four noteworthy results. First, there is no statistically significant difference between treatments in the mean absolute estimation error in period 1 (individual contributions as observations, two-sided Mann-Whitney test,  $p=0.406$ ). Second, there is a significant drop in the mean absolute estimation error from period 1 to period 2 (Wilcoxon signed-rank tests,  $p=0.008$  in non-incentivized beliefs;  $p=0.000$  under incentivized beliefs). Third, from period 2 to 10 belief accuracy stays roughly constant, in particular under incentivized beliefs (similar to Croson (2000), Fig. 2, p. 307). Finally, in each of periods 2 – 10 the mean absolute error is higher under non-incentivized beliefs than under incentivized beliefs. This difference is

highly significant according to a two-sided Mann-Whitney test applied to the groups' average absolute estimation errors across all periods ( $p=0.00085$ ). A regression analysis (using a multilevel mixed random effects regression which allows for individual and group differences, as well as for treatment-specific residuals) confirms this result (see Table A1 in the appendix).

*Result 2.* The *relationship* between beliefs and contributions is slightly steeper under incentivized than non-incentivized belief elicitation.

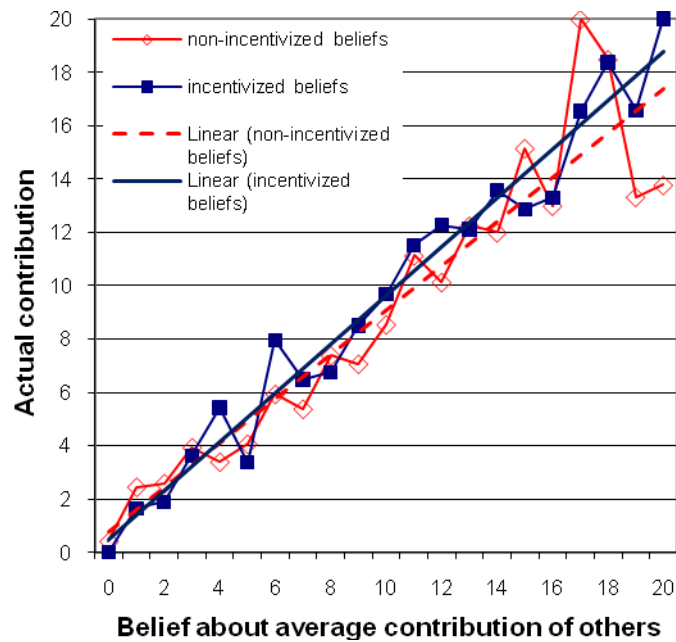
*Support.* Figure 2 provides graphical and Table A2 in the appendix econometric support. Figure 2 shows the mean contribution for a given mean estimated contribution of the other group members. Like in previous experiments beliefs and contributions are positively correlated.<sup>7</sup> When beliefs are incentivized the relationship between beliefs and contributions is slightly stronger.<sup>8</sup>

Result 2 makes sense for the following reason (see also Rutström and Wilcox (2009) whose arguments we apply here): Suppose that estimating beliefs requires cognitive effort that is subject to random error and the random error depends on the effort subjects put into the estimation. The incentivized beliefs treatment gives subject an incentive for higher thinking effort and this should reduce the variance in the estimation error. Result 1 supports this reasoning. Since the “measurement error” of beliefs is reduced under incentivized beliefs, the correlation between beliefs and contributions should be strengthened. This is the case empirically – hence Result 2.

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<sup>7</sup> There can be different reasons for such a correlation: people might project their own contributions on others (e.g., Dawes, et al. (1977)), or it might be an expression of reciprocity or “conditional cooperation” in general (e.g., Fischbacher, et al. (2001); Fischbacher and Gächter (2010); Croson (2007); Kocher, et al. (2008); Muller, et al. (2008); Herrmann and Thöni (2009); Neugebauer, et al. (2009); Thöni, et al. (2009)). Notice, however, that the purpose of the present paper is not to explain this relation but simply to see whether incentivized beliefs change this relationship, as compared to non-incentivized beliefs.

<sup>8</sup> This result is not robust to the estimation method, because the increase is only significant under the multi-level random effects model but not in the Tobit random effects model (see Table A2 in the appendix). However, the Tobit model does not account for treatment-specific residuals. Since Result 1 showed that variance is lower under incentivized beliefs than under non-incentivized beliefs controlling for treatment-specific variances seems to be warranted. This argument favors the multilevel random effects model where we allow for treatment-specific residuals.



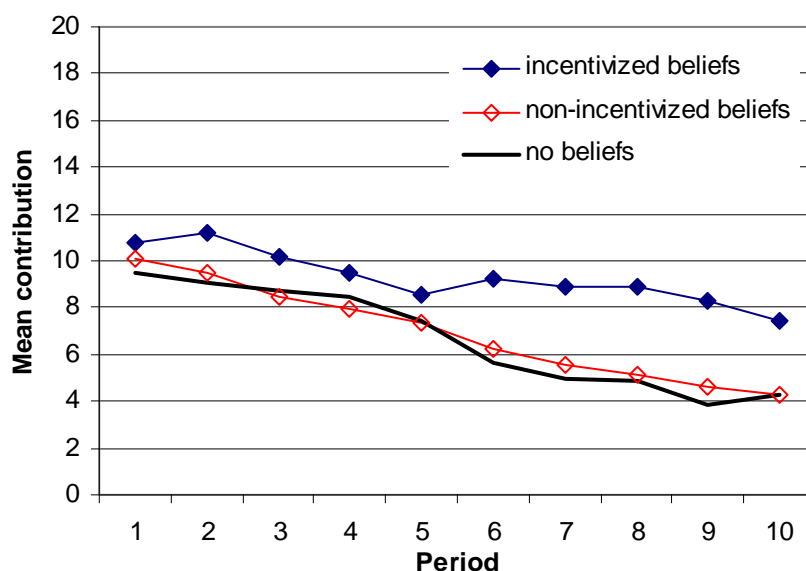
**Fig. 2** The relationship between beliefs and contributions.

*Result 3.* Eliciting beliefs does not change contribution *levels* relative to the no beliefs treatment if beliefs are not incentivized. By contrast, if beliefs are incentivized, we observe higher contributions in particular in the second half of the experiment.

*Support.* Figures 3, non-parametric tests, and regressions (Table A3 in the appendix) provide the support for Result 3. Qualitatively, the usual picture of a declining trend emerges in all treatments (see Ledyard (1995); Herrmann, et al. (2008); Fischbacher and Gächter (2010)). Yet, eyeballing the time trend suggests some differences between treatments, in particular towards the end of the experiment and when beliefs are incentivized.

A statistical analysis confirms these impressions. First, a Kruskal-Wallis test with group average contributions across all periods weakly rejects the null hypothesis that the group averages are identically distributed across treatments ( $p=0.079$ ). Pair wise Mann-Whitney tests (using group averages across all periods) show that contributions are weakly significantly different between incentivized beliefs and non-incentivized beliefs ( $p=0.0539$ ); not significantly different between no beliefs and non-incentivized beliefs ( $p=0.8819$ ) and weakly significantly different between no beliefs and incentivized beliefs ( $p=0.05124$ ).

Period-by-period Kruskal-Wallis tests show that significant differences only emerge after period 5, where  $p \leq 0.04$  in all periods. Pair wise tests for periods 6 to 10 between no beliefs and non-incentivized beliefs reveal no significant differences (all  $p > 0.58$ ). Pair wise comparisons between no beliefs and incentivized beliefs show significant differences at  $p < 0.05$ .



**Fig. 3** Contribution levels over time.

Result 3 is surprising given that Croson (2000) finds that contributions *decrease* when beliefs are elicited whereas Wilcox and Feltovich (2000) find that contributions are *not* affected by whether beliefs are elicited or not. Since we did not set up our experiment as a replication of neither of Croson’s nor of Wilcox and Feltovich’s (2000) study, any explanation of why our results differ from theirs is somewhat speculative.

One obvious possibility is differences in designs of the three studies. Our experiment is most similar to Croson’s design: Many parameters were the same (groups of four participants, and ten periods in a “partner” design) or similar (in Croson’s experiment subjects had an endowment of 25 tokens and the marginal per capita rate was 0.5). There is one bigger difference between our designs and Croson’s, however, and this concerns the actual level of stakes for correct beliefs.<sup>9</sup> To see this, recall that we asked subjects for their guess of the

<sup>9</sup> We are grateful to a referee who pointed out this possibility.

*average* contribution level of the other group members. Given subjects' endowment of 20 the average is therefore between 0 and 20. By contrast, Croson (2000) rewarded subjects for the accuracy of the *sum* of others' contributions, which, given subjects' endowment of 25 tokens, ranged between 0 and 75 tokens. Although the reward for a correct guess was similar in our experiment than in Croson's<sup>10</sup>, the difference in the range of outcomes was more than three times lower in our experiment than in hers. Therefore, the stakes were arguably much steeper in our experiment than in hers and might have induced subjects in our experiments to coordinate to garner the rewards for exact prediction. Why our subjects might have coordinated on higher contributions is an open question.

Wilcoxon and Feltovich's (2000) design is less similar to Croson's (2000) and our study: Their groups consisted of six subjects who played for six periods. Their marginal per capita return was 0.25 and the contribution decision was binary to either contribute an endowment of one token or not. Also the incentives on beliefs were implemented in a different way: One person per group was randomly selected and paid \$10 if, in a randomly selected round, he or she had correctly guessed how many of the five other group members had had contributed to the public good. Given these differences it is difficult to directly compare these studies and attribute the different results to specific design features.

We also don't know whether our explanation of different incentives for correct beliefs really is the explanation for the differences in results between Croson (2000) and our study. Only new experiments, which would need to include *exact* replications of their experiments, could tell. However, for the purposes of this paper the explanation of differences in results does not matter. What matters is that our results, as well as Croson's, show that incentivized belief elicitation *can* have strong consequences, which experimentalists, who design new experiments, should be aware of. We discuss potential implications for the design of experiments in the next section.

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<sup>10</sup> In both experiments a correct guess (+/- .5 points in our experiment) earns a subject an amount equivalent to the endowment in each period (25 points in Croson's experiment, 20 points in our experiment) and half that amount divided by the (absolute) estimation error is paid for all other guesses.

#### 4. Concluding discussion

In our view, the implications of our results for the design of public goods experiments depend on the actual research question. If beliefs are the focus of interest, then our Result 1 suggests that beliefs should be incentivized because belief accuracy is higher when beliefs are incentivized than when they are hypothetical. If the researcher is mainly interested in the *relationship* between beliefs and contributions, then our Result 2 suggests that incentives on beliefs do strengthen this relationship, although the effect is quite small. If the researcher is afraid that belief elicitation leads to behavioral results that he or she would not obtain when not asking for beliefs, then our Result 3 suggests that belief elicitation should not be incentivized, because without incentives for correct beliefs we did not get a significant difference between the no belief treatment and the non-incentivized beliefs treatment. If beliefs are incentivized, interaction effects of beliefs and contributions are likely to exist and can, given our results and those of Croson (2000) and Wilcox and Feltovich (2000), apparently go in either direction.

Whatever the explanation for these conflicting findings is, one point seems clear and was already pointed out by Croson (2000), p. 312: “If the act of eliciting beliefs affects behavior, experimentalists need to think carefully about their procedures and the information collected in their experiments. In particular, they need to examine and take into account the possible effects of their elicitation procedures on behavior.” Our results firmly support this conclusion. In particular, Result 1 and 3 suggest that, depending on the research question, the researcher may face a tradeoff: high incentives for exact beliefs increase belief accuracy but strongly incentivized beliefs may also bias contributions away from levels that would be observed were beliefs not elicited at all or only hypothetically.

We are of course aware that, in a strict sense, our conclusions only have validity in the context of public good experiments. However, (i) given the importance of beliefs in theoretical models, (ii) an increased attention to beliefs by empirical economists (e.g., Manski (2004)) and behavioral game theorists (e.g., Dufwenberg and Gneezy (2000); Nyarko and Schotter (2002); Bhatt and Camerer (2005); Costa-Gomes and Weizsäcker (2008)) and (iii) the findings of Croson (2000) and Wilcox and Feltovich (2000) and our new results, we think it is a methodologically important task to investigate the impact of (incentivized) belief elicitation in other economically interesting tasks as well.

## Appendix: Regression analyses

In the regression analyses we used two approaches. First, a multilevel mixed random effects regression which allows for individual and group differences, as well as for treatment-specific residuals, and second a random effects Tobit estimation (controlled for individual differences) to account for the fact that the data are censored.<sup>11</sup>

### Table A1: Mean absolute estimation error (Result 1)

Table A1 reports the results of a regression where the dependent variable is the mean absolute estimation error, and the independent variables are a dummy for the incentivized beliefs treatment, the period index, a dummy for the first period, and two interaction variables to control for treatment-specific differences. The results show that the mean absolute estimation error is highly significantly lower under incentivized beliefs than under hypothetical beliefs (the benchmark). The estimation errors are reduced over time and are significantly higher in the first period compared to the rest. All these observations are robust to the estimation method (multilevel mixed random effects with treatment-specific residuals, or random effects Tobit).

**Table A1:** Mean absolute estimation error under incentivized and non-incentivized belief elicitation

Mean absolute estimation error (absolute difference between stated belief and actual average contribution of others)		
	Multilevel mixed random effects	Random effects Tobit
Dummy Incentivized Beliefs (IB)	-1.430*** (0.484)	-1.505*** (0.464)
Period	-0.093** (0.047)	-0.121*** (0.044)
Period×IB	0.066 (0.059)	0.077 (0.063)
First period	1.203*** (0.395)	1.183*** (0.418)
First period×IB	1.043* (0.563)	1.107* (0.600)
Constant	3.959*** (0.367)	4.007*** (0.323)
$\sigma(\text{group})$	0.684*** (0.171)	
$\sigma(\text{subject})$	1.002*** (0.119)	1.239** (0.116)
$\sigma(\text{residual})$		2.779*** (0.060)
$\sigma(\text{residual non-incentivized beliefs treatment})$	2.977*** (0.085)	
$\sigma(\text{residual incentivized beliefs treatment})$	2.219*** (0.065)	
Observations	1320	1320
Wald chi2(5)	98.70***	93.72***

Standard errors in parentheses; \*p < 10%; \*\* p < 5%; \*\*\* p < 1%

<sup>11</sup> We used the software package Stata 11 for estimation. We estimated the multilevel random effects model using the `xtmixed` command and for the random effects Tobit we used the `xttobit` command.

**Table A2: Correlation between contributions and beliefs (Result 2)**

We regress contributions on elicited beliefs, the period index, and interaction variables with the incentivized beliefs treatment. The random effects regression finds that under incentivized beliefs contributions appear to be significantly higher than under non-incentivized beliefs (the benchmark). However, this result is not robust to the estimation method, because in a random effects Tobit regression the coefficient on “Belief×Dummy incentivized beliefs treatment” loses its significance. Due to substantial left and right censoring of the data (32.6 percent of all observations are 0 or 20) the Tobit approach might be more appropriate.

**Table A2:** The correlation between contributions and beliefs

	Contributions	
	Multilevel mixed random effects <sup>#</sup>	Random effects Tobit
Belief about average contribution of others	0.660*** (0.045)	0.986*** (0.064)
Belief×Dummy incentivized beliefs treatment	0.134** (0.066)	0.084 (0.098)
Dummy incentivized beliefs treatment	-1.003 (1.067)	-0.688 (1.546)
Period	-0.232*** (0.062)	-0.396*** (0.083)
Period×Dummy incentivized beliefs treatment	0.167** (0.081)	0.268** (0.112)
Constant	3.034*** (0.747)	0.064 (1.040)
$\sigma(\text{subject})$	3.413*** (0.240)	5.060*** (0.376)
$\sigma(\text{residual})$		4.925*** (0.130)
$\sigma(\text{residual non-incentivized beliefs treatment})$	4.089*** (0.117)	
$\sigma(\text{residual incentivized beliefs treatment})$	3.484*** (0.103)	
Observations	1320	1320
Wald chi2(5)	704.53	621.39

<sup>#</sup> Controlling for both group and individual differences eliminated the group level. In this estimation we therefore only controlled for individual differences.

Standard errors in parentheses; \*p < 10%; \*\* p < 5%; \*\*\* p < 1%



**Table A3: Contributions as a function of treatment and time (Result 3)**

Table A3 reports regression results that relate contributions to treatment dummies, the period index, and two interaction variables of period and treatment, to detect treatment-specific differences in the temporal development of contributions. The results show that contributions are significantly higher over time in the incentivized beliefs treatment, compared to the control treatment. By contrast, contributions in the non-incentivized treatments do not develop significantly differently from the control treatment. These findings are robust to the estimation technique (multilevel mixed random effect, or random effects Tobit).

**Table A3: Contributions as a function of treatment and time**

	contribution	
	Multilevel mixed random effects	Random effects Tobit
Dummy non-incentivized beliefs treatment	0.108 (1.262)	0.049 (1.305)
Dummy incentivized beliefs treatment	0.716 (1.269)	0.551 (1.314)
Period	-0.698*** (0.065)	-1.003*** (0.087)
Period×Dummy non-incentivized beliefs treatment	0.025 (0.089)	-0.036 (0.127)
Period×Dummy incentivized beliefs treatment	0.346*** (0.086)	0.506*** (0.124)
Constant	10.509*** (0.887)	11.138*** (0.903)
$\sigma(\text{group})$	2.939*** (0.412)	
$\sigma(\text{subject})$	3.227*** (0.221)	6.234*** (0.367)
$\sigma(\text{residual})$		6.205*** (0.133)
$\sigma(\text{residual no beliefs treatment})$	4.999*** (0.138)	
$\sigma(\text{residual non-incentivized beliefs treatment})$	4.604*** (0.132)	
$\sigma(\text{residual incentivized beliefs treatment})$	4.073*** (0.120)	
Observations	2040	2040
Wald chi2(5)	281.18***	297.55***

Standard errors in parentheses; \*p < 10%; \*\* p < 5%; \*\*\* p < 1%

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## Supplementary Material to Simon Gächter and Elke Renner: “The effects of (incentivized) belief elicitation in public goods experiments”.

### Instructions

*Differences between the “no beliefs”, “incentivized beliefs” and “non-incentivized beliefs treatment” are indicated in the text. The instructions used in the experimental sessions in Erfurt were in German and are available from the authors upon request*

#### General Information on the Experiment

You are taking part in an experiment on decision-making. If you read the following instructions carefully, you can, depending on your decisions, earn a considerable amount of money. It is therefore very important that you understand the following instructions.

- **Earnings**

In the experiment you earn points. The points you have earned will be converted in Euros at the rate

$$1 \text{ point} = 0.20 \text{ €}$$

At the end of the experiment your total income in Euros will be paid to you in cash.

- **Group membership and anonymity**

During the experiment you are member of a group of four participants, i.e. there will be three more members in your group. The composition of the group will be the same during the whole experiment. Thus you form a group with the same participants throughout the experiment. It will be randomly determined with whom of the other participants you will form a group.

All participants decide anonymously, i.e. no participant will ever learn the identity of the other members of his group. To ensure anonymity it is imperative that all participants observe the following rule:

**During the experiment all communication is prohibited, i.e. you are not allowed to speak or otherwise express yourself.**

Should you have any questions please ask the experimenter.

#### The Experimental Procedures

The experiment consists of several periods.

##### **The decision situation in period 1-10**

The procedure is the same for each of these periods 1-10. Every participant receives **20 tokens** at the beginning of each period. Your task is to decide how you use your endowment. You have to decide how many of the 20 tokens you want to contribute to a project and how many of them to keep for yourself.

## The calculation of your income

Your income consists of two parts:

- 1) The **tokens which you have kept for yourself** (“Income from tokens kept”) whereby 1 token = 1 point.
- 2) The **income from the project**. This income is calculated as follows:

Your income from the project =  $0.4 \times$  the total contribution of all 4 group members to the project

Your income in points is therefore:

$$(20 - \text{your contribution to the project}) + 0.4 * (\text{total contributions of all 4 group members to the project})$$

The income of each group member from the project is calculated in the same way, this means that each group member receives the same income from the project.

### Examples:

Suppose the sum of the contributions of all group members is 60 tokens. In this case each member of the group receives an income from the project of:  $0.4 * 60 = 24$  points.

If the total contribution to the project is 9 tokens, then each member of the group receives an income of  $0.4 * 9 = 3.6$  points from the project.

For each token, which you keep for yourself you earn an income of 1 point. Suppose you contributed this token to the project instead, then the total contribution to the project would rise by one point. Your income from the project would rise by  $0.4 * 1 = 0.4$  points. However the income of the other group members would also rise by 0.4 points each, so that the total income of the group from the project would rise by 1.6 points. Your contribution to the project therefore also raises the income of the other group members. On the other hand you earn an income for each point contributed by the other members to the project. For each point contributed by any member you earn  $0.4 * 1 = 0.4$  points.

- **How to take your decision**

At the beginning of each period you will see the following input-screen:

The screenshot shows a software interface for a group decision task. At the top left, there is a field labeled 'Periode' with the value '1'. In the top right corner, a red message reads 'Bitte entscheiden Sie sich jetzt!'. The main area contains the text 'In Ihrer Gruppe befinden sich 4 Teilnehmer'. Below this, it states 'Ihre Ausstattung beträgt 20' and 'Ihr Beitrag zum Projekt' followed by a blue input box. Further down, it asks for 'Ihre Einschätzung; durchschnittlicher Beitrag der übrigen Gruppenmitglieder' with another blue input box. At the bottom right of the main area is a red 'OK' button. At the bottom left, there is a 'Hilfe' section with the text: 'Bitte geben Sie Ihren Beitrag ein. Wenn sie fertig sind, klicken Sie mit der Maus den \*OK\*-Knopf.'

The period number appears in the top left of the screen. In the middle of the screen you will find the information that your group consists of 4 members and that your endowment is 20 tokens.

You take your decision by typing a number between 0 and 20 in the input field. This field can be reached by clicking it with the mouse. As soon as you have decided how many points to contribute to the project, you have also decided how many points you keep for your self: This is  $(20 - \text{your contribution})$  tokens. After entering your contribution you must press the O.K. button (either with the mouse, or by pressing the Enter-key). Once you have done this, your decision can no longer be revised.

**[In both treatment with belief elicitation:** Below the decision field is another input field labelled “My estimate: Other group member’s average contribution”. Please type in what you think will be the average contribution of the other three members in your group.]

**[In the treatment with non-incentivized belief elicitation:** This estimate has no implications for your payoff.]

**[In the treatment with incentivized belief elicitation:** In addition to your earnings from your decision you will be paid an extra amount depending on how close your estimate is to the actual average contribution of the other group members. If your estimate is exactly right or not more than 0.5 points away from the actual average payoff you will earn 20 points. If your estimate is further off than 0.5 points you will earn 10 points divided by the (absolute) distance between your estimate and the actual average contribution.]

After all four group members have taken their decision you will see an income screen that informs you about your contribution, the total contribution of all members of your group (including your contribution) and your payoff from your decision.

Do you have any questions?