How laws affect behavior: Obligations, incentives and cooperative behavior

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ABSTRACT

Laws and other formal rules are 'obligations backed by incentives'. In this paper we explore how formal rules affect cooperative behavior. Our analysis is based on a series of experimental public good games designed to isolate the impact of exogenously requested minimum contributions (obligations) from those of the marginal incentives backing them. We find that obligations have a sizeable effect on cooperative behavior even in the absence of incentives. When non-binding incentives are introduced, requested contributions strongly sustain cooperation. Therefore, in contrast with cases in which incentives crowd-out cooperative behavior, in our experiments obligations and incentives are complementary, jointly supporting high levels of contributions. Moreover, we find that variations in obligations affect behavior even when incentives are held constant. Finally, we explore the behavioral channels of the previous results, finding that people's beliefs about others' contributions and the willingness to cooperate are both called into play.

1. Introduction

Formal rules and public policies play a fundamental role in regulating people's daily interactions. Traditionally, economists have studied the design of optimal rules and laws by focusing on their enforcement and on designing optimal incentives. By focusing almost exclusively on the role of incentives, economics literature neglected a crucial aspect that is usually taken into account by legal scholars interested in developing good laws: laws and formal rules are "*obligations* backed by *incentives*".[1] The obligation part of a formal rule consists in the behavior the rule states people should maintain, and the incentives part relates to the consequences for maintaining or violating the requested behavior.[2] Legal theorists and social psychologists[3] suggest that laws are effective in regulating people's behavior not only through the enforcement structure, but also in what they ask of people, or signal.[4] Under this perspective, the normative content of the rule can activate people's motivation and can induce compliance as the material incentive enforcing the rule itself. Moreover, by stating formally how people should behave, formal rules provide a focal point that helps people coordinate. If we think to compliance with law as a public good, this effect is likely to be crucial in the presence of conditional co-operators (Fischbacher and Gaechter, 2010), because in such a situation a public good game is equivalent to a coordination game (Camerer and Fehr, 2002). Understanding the interaction between incentives and obligations (the content of the norm) is thus crucial for developing public policies. In this work we experimentally study how obligations work and how they interact with incentives in affecting human behavior. In particular we explore the following questions:

(i) How do obligations per se affect cooperative behavior?
(ii) How do non-binding incentives per se affect cooperative behavior?

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[1] See Raz (1980).

[2] Typically, a formal rule is a statement such as: "you ought to... and then you will get..." (or "you ought to... or else you will pay..."). In this sentence, incentives are captured by the "and you will get/or else you will pay ..." part, and obligations by the "you ought to..." component.

[3] See Tyler (1990).

[4] See Kahan (1997), Cooter (2000) and McAdams (2000), Croson (2009). In economics, the theoretical work by Bar-Gill and Fershtman (2004) and Bowles and Polania-Reyes (2012) explore the possibility that laws affect behavior by driving the evolution of preferences. Van der Weele (2012) explores and develops a model of the signaling power of legal rules.

(iii) How do obligations and non-binding incentives interact with each other?
(iv) What are the channels through which obligations and non-binding incentives affect behavior?

Our analysis is based on a series of linear public goods experiments[5] in which we independently vary the intensity of incentives and the level of obligations. Obligations are introduced in the form of a minimum contribution: "a minimum contribution of X tokens to the public good is required from each individual". Incentives are implemented as probabilistic punishments for contributions below the minimum and probabilistic rewards for contributions above the minimum. The incentive schemes are structured in such a way that not contributing to the public good remains the dominant strategy for payoff-maximizers. Thus, our incentive structure is non-binding and marginal payoffs are independent of the minimum contribution. Hence, if we observe any difference in results across treatments with different minimum contributions, this cannot be attributed to the effect of incentives on payoffs, but its justification should be sought elsewhere.

The overall picture emerging from our experimental results is as follows. The introduction of an obligation in the absence of incentives leads to an increase in the provision of the public good. This means that the introduction of a rule, even if not enforced, positively affects people's propensity to cooperate. Instead, the introduction of non-binding incentives without an obligation does not significantly affect contributions. When obligations and incentives are combined, cooperation is strongly reinforced: the joint effect of incentives and obligations on contributions is significantly more positive than the impact of obligations alone. This means that obligations and incentives are complementary, jointly supporting high levels of contribution. This last aspect is particularly relevant: this means that, when combined with an obligation, incentives crowd-in reasons for behavior other than a material self-interest in sustaining cooperation.[6]

In order to provide a behavioral interpretation of these results, we analyze the possible channels driving cooperation. We find that obligations affect behavior through two channels: (i) given beliefs about the behavior of others increase people's willingness to contribute, and (ii) they increase people's beliefs concerning the contributions of others. Since most participants are conditional co-operators, both these effects raise the contribution to the public good. Non-binding incentives per se do not affect individuals' beliefs and preferences. Instead, when combined with obligations, they strongly reinforce the impact of obligations through both channels.

The paper is structured as follows. Section 2 provides a review of the related literature. Section 3 reports the experimental design and behavioral predictions. Section 4 describes and comments on the results. Section 5 provides some concluding remarks.

[5] The choice to carry out our experimental investigation in a public good setting is motivated by the fact that formal rules, and in particular legal rules, are often set by legislators and governments with the specific objective of overcoming social dilemmas (e.g. free riding in income tax compliance, common pool resource management, traffic behavior, or environmental regulation) by aligning private incentives to the common good.

[6] From this point of view, this study contributes to a burgeoning literature in behavioral economics aiming to provide us with a greater understanding of the psychological effects of incentives (see among others Benabou and Tirole, 2003, 2006; Bohnet et al., 2001; Falk and Kosfeld, 2006; Falk et al., 2005, 2006; Fehr and Falk, 2002; Fehr and Schmidt, 2002; Fehr and List, 2004; Frey and Jegen, 2001; Gneezy and Rustichini, 2000a,b; Kube and Traxler, 2009; Van Der Weele, 2012; Galbiati et al., 2013).

2. Literature review

Our study relates to several strands of the literature. First, there is extensive literature developed in the last decade on the effects of institutions in the provision of public goods. In particular, our study relates to the literature focusing on exogenously imposed institutions. Falkinger et al. (2000) examine a mechanism for public good provision in which rewards and sanctions are imposed to players who contribute to the public good more and less than the average. The authors demonstrate experimentally that the mechanism is an effective tool to implement efficient contribution levels. Andreoni (1993) presents an experimental test of the proposition that government contributions to public goods, funded by lump-sum taxation, will completely crowd-out voluntary contributions. The author finds that crowding-out is incomplete and that subjects who are taxed are significantly more cooperative.

Another strand of literature focuses on the crowding-out/crowding-in effects of incentives. Fehr and Falk (2002), Frey and Jegen (2001) and Bowles and Polania-Reyes (2012) provide excellent surveys of the topic. Our paper complements this literature by showing the crowding-in effect of incentives to the public good, when these are coupled with obligations. Our results show that incentives and obligations are complementary, and mutually sustain the effect of the other in enhancing cooperation, while when "mild" incentives are used alone they are ineffective. Another contribution of our paper is to further the research on analyzing the channels of this effect. Most papers in this field are not able to single out the channels of the treatment effects (i.e. the effects of introducing incentives or changing institutions). For example, a much cited paper (Gneezy and Rustichini, 2000b) showed that a fine for picking up children late from a day-care center actually increased late-coming but could not document the channel thorough which fines induced more late coming. By eliciting participants' beliefs and conditional contributions, our experimental design can show how obligations and incentives affect the behavioral motivations of behavior experimental subjects.

Our work also relates to the literature in legal scholarship on the Focal Point Theory of (Expressive) Law (McAdams, 2000; McAdams and Nadler, 2005). According to this theory, laws can be used to coordinate expectations on a beneficial equilibrium. In an experiment by Bohnet and Cooter (2005), penalties for choosing the inefficient strategy in a coordination game induce more people to choose the efficient strategy. Our experimental results go in a similar direction by showing that the basic components of formal rules (obligations and incentives) complement each other by inducing conditional cooperators to increase their contributions to the public good. A further strand of legal literature that relates to our paper is that on "expressive law" (e.g. Kahan, 1997; Cooter, 2000). The idea herein is that laws express the reigning norms in a society, and can discipline people by showing them what the majority of people deem (to be) 'appropriate'. Funk (2007) reports field results in line with this intuition. Using a Swiss panel data, she finds that the legal abolishment of the voting duty significantly decreased the average turnout, even though the fines for not voting have only been minimal. Our results on obligations sustain this intuition and our analysis of conditional contribution schedules shows that the willingness to contribute to the public good can be "anchored" to the level of obligations.

In a recent paper related to ours, Tyran and Feld (2006) run an experiment that compares the effects of endogenously and exogenously introduced 'mild' or 'non-deterrent' sanctions in a public good game. In the endogenous treatment, the subjects vote on whether to introduce the sanction. The authors show that endogenous sanctions are more effective in raising contributions than exogenously implemented sanctions. The interpretation of this result is that endogenous sanctions signal that there are many

people who want to cooperate. Our results on incentives complement this result by showing that a variation in exogenously imposed mild sanctions does not affect contributions to the public good when incentives are not coupled with obligations. On the other hand, exogenous mild incentives complement the positive effect of obligations on cooperation when they are used together.

Finally this paper relates to a previous work by Galbiati and Vertova (2008) that documents the positive effect of obligations on cooperation in a dynamic voluntary contribution mechanism. In this paper we report and discuss the evidence from new experimental treatments designed to understand: (a) the separate effect of obligations and incentives on cooperation; (b) the combined effect of obligations and incentives; and (c) the behavioral channels driving these effects.

3. Experiment

3.1. The experimental game

The basic experiment consists of a one-shot linear public good game, followed by a conditional contribution stage. Overall, we ask participants to make two choices. The first is a choice of 'unconditional contribution': subjects are asked to make their contributions to the public good. After all subjects have chosen their unconditional contribution, we ask participants to make their choices of 'conditional contribution', that is to say, to select how much to contribute to the public good in relation to different average contributions by the other group members. Finally, we elicit individual beliefs about the others' unconditional contributions. Individuals will find out what the others have decided and their own payoff only after all three of these stages have been completed.

The linear public good game we implement differs from a standard voluntary contribution mechanism in that we exogenously set a minimum level of contribution that each subject is required to provide to the public good. The game has two main variants. The first without incentives at all: we simply introduce the requested minimum contribution without any form of monitoring of individuals' actual behavior. In the second variant, the minimum contribution is backed by a structure of incentives: there is a probability of being monitored and a probabilistic penalty (reward) for individuals whose contributions are lower (higher) than the minimum level of contribution required.[7] We are interested in understanding whether the minimum contribution has a different effect in the presence or in the absence of incentives, and in the second case we want to isolate its effects from those of the marginal incentives. Therefore, we keep the level of marginal incentives fixed across all treatments, i.e. the probability of being audited and the penalty/reward rate do not vary with the minimum contribution obligation. On the contrary, the level of the required minimum contribution changes across the treatments. The incentives are fixed at a very low level. There are two reasons behind this choice: firstly, we aim to test whether or not the obligation of a minimum contribution affects cooperation when incentives are such that the optimal strategy for self-interested individuals is full free-riding, even if they are risk-averse to a reasonable degree. Secondly, we want to minimize the possible bias in our results caused by differences in risk preferences across samples.[8]

In the one-shot public good game (unconditional contribution stage), the expected monetary payoff for individual i is:

$$X_i = y - a_i + m\sum_{j=1}^{n} a_j - pg(\hat{a} - a_i) \quad (1)$$

where y is the individual endowment, a_i is the individual contribution to the public good, m indicates the marginal per capita return to the public good $A \equiv \sum_{j=1}^{n} a_j$, p is the probability of an audit, and g is the penalty/reward rate. We set the parameters so that the following inequalities hold: $m > 1/n$ and $m + pg < 1$. In the variant without incentives we fix $pg = 0$.

In order to understand whether a possible effect of the minimum contribution on cooperation should be attributed to an influence on preferences, on beliefs, or on both, and if such motivational channels are affected by the presence or absence of incentives, we need to understand: (a) if individuals' beliefs about others' contributions are significantly different in the different treatments; (b) if, given the others' hypothetical contributions, individuals' conditional behavior significantly varies in the different treatments. In order to pursue the latter aim, in all the treatments we elicit the subjects' "conditional contributions" by applying a variant of the so-called "strategy method" (Selten, 1967), as developed in the experimental design by Fischbacher et al. (2001). After the unconditional contribution stage, subjects are asked to report their conditional contributions. In particular, each subject has to fill in a conditional contribution table: for each possible level of average contribution in the group, and given the level of minimum obligation, the individual has to declare how much they want to contribute to the public good. To give subjects a material incentive to take their conditional contribution decisions seriously, we follow the procedure designed by Fischbacher et al. (2001). Subjects are told that, after they have taken both decisions, a random mechanism will select which of the two decisions becomes effective in determining their payoffs. In each group, one subject is randomly selected. For this subject the conditional contribution table determines their actual contribution to the public good, whereas for the other group members the relevant decision is the unconditional contribution. This mechanism ensures that all entries in the conditional contribution table are potentially relevant in determining the payoffs of each subject.

After all the players have decided how much to contribute to the public good, the monitoring stage takes place: a player's contribution may be randomly monitored (with probability p) and the player may get a monetary reward (sanction) if they have contributed more (less) than the minimum contribution required by the obligation. Finally, in order to have a proxy of what people believe the others' contributions to be, in each treatment we ask each subject what they expect the others in their group have contributed on average to the unconditional contribution decision. In order to give an incentive to take this decision seriously, those who actually make the right prediction gain an additional monetary payment.

3.2. Treatments, parameters and procedures

In order to investigate our research questions, we implement six different experimental treatments: two treatments without incentives, three treatments with the same incentive structure and finally a treatment with a very low level of incentives. Table 1 summarizes the experimental treatments.

The PG treatment is a baseline public good game without a material incentive to contribute. In treatment H(no-i) we introduce a required minimum contribution equal to 80% of an individual's total endowment. This second treatment simply works as a baseline voluntary contribution mechanism with a suggested contribution that

[7] The penalty (reward) is proportional to the negative (positive) difference between the actual contribution and the minimum contribution required.

[8] Nevertheless we check the robustness of our results by controlling for differences in risk preferences (see Appendix 1).

Table 1
Experimental treatments.

	Obligation (required minimum contribution)		
	No (0)	Low (4)	High (16)
Incentives (detection probability)			
No (0)	PG		H(no-i)
Low (1/100)			H(low-i)
High (1/12)	0	L	H

we can consider as third-party cheap talk. The treatments with a monitoring structure are the following. We have three treatments with a probability of monitoring $p = 1/12$: a 0 treatment, where no minimum contribution is required and subjects obtain a reward if they are monitored and their contributions to the public good are higher than zero; a low minimum contribution treatment (L), where subjects are required to contribute at least 20% of their initial endowment; and a high minimum contribution treatment (H), where the minimum contribution required corresponds to 80% of an individual's total endowment. In both these last treatments individuals' contributions can be monitored. If they contribute less (more) than the required contribution, they get a penalty (reward). As we are interested in the effects of obligations per se, we keep the level of marginal incentives (i.e. the probability of being audited and the penalty/reward rate) fixed across all treatments.

In the instructions we stress that the obligation sets a minimum contribution required from each individual, but that the feasible contribution for each participant varies between 0 and their overall endowment. We also explain in detail the consequences of each choice on individual payoffs. In the last treatment (H(low-i)) the level of minimum contribution is fixed at a level closer to zero (detection probability $p = 1/100$) to allow us to further investigate the role of incentives and to be sure that the effects we find depend on their presence and not on their level. A comparison between the two high obligation conditions with different incentive levels and the baseline condition without obligations provides us with information about the effect of varying marginal incentives on levels of cooperation.

The parameters of the game are set as follows. The initial endowment is $y = 20$, the number of subjects per group is $n = 6$, the marginal per capita return to the public good is $m = 0.3$, the probability of being monitored is $p = 1/2$[9] (but $p = 1/100$ in the H(low-i)), the sanction/reward rate is equal to $g = 1.2$ (this ensures that: $m > 1/n$ and $m + pg < 1$), the minimum contributions fixed by the obligation are $\hat{a} = 4$ in treatment L, and $\hat{a} = 16$ in treatment H, respectively.

The experiment was conducted in a computerized laboratory where subjects interacted with each other anonymously.[10] No subject was ever informed about the identity of the other group members. We did not provide information about other individuals' contributions in the same group. At the end of the game subjects were only provided with information about their own payoff. This should rule out emotional elements related to stigma and shame in the explanation of the results. We conducted six sessions, one for each treatment. In each session participants were divided into 6 groups of 6, with the exception of H (no-i), which has 5 groups of 6, for a total of 210 subjects. Subjects were undergraduate students from different faculties. Each subject participated in one session only and nobody had previously participated in other public good experiments. The experiment was conducted in the experimental laboratory of the University of Siena (Italy), in different sessions from December 2005 to April 2008. Each session lasted about one hour, and the average earnings for each subject were 14 Euros (about 20 US dollars).

3.3. Predictions and testing

Hereafter we report the kind of comparisons that we made in order to answer each of the questions reported in the introduction, together with some predictions of expected behavior.

3.3.1. How do obligations per se affect cooperative behavior?

In order to answer these questions we compare: (a) unconditional contributions in the H(no-i) treatment to contributions in the PG treatment and (b) unconditional contributions in the H, L and 0 treatments respectively.

If we assume common knowledge of rationality, risk neutrality and selfishness of all players, we expect that in every treatment the unconditional contribution of each subject will be equal to zero, and that conditional contribution entries will all be zero for each subject. For example, let us consider in our setting the optimal choice by a risk-neutral and fully self-interested individual. Their optimal contribution, a_i^*, is the value of a_i which maximizes (1). The first order condition of the maximization problem yields:

$$\frac{\partial X_i}{\partial a_i} = -1 + m + pg < 0 \tag{2}$$

Hence, the dominant strategy for a (risk-neutral) self-interested individual is always full free riding: $a_i^* = 0$. This result depends crucially on the assumption that $m + pg < 1$, meaning that the monetary incentives are not sufficiently high to make the expected return from one unit of contribution higher than the unit kept for oneself. Notice that the level of minimum contribution obligation $\hat{a}$ does not affect the optimal choice of a self-interested individual. This is straightforward since minimum contributions do not affect marginal monetary payoffs. In order to satisfy this condition, our setting presents both a probabilistic penalty for those who contribute less than the minimum contribution and a probabilistic reward for those who contribute more. Notice that if we had instead applied only a probabilistic penalty (or only a probabilistic reward) for individuals who contribute less (more) than $\hat{a}$, we would have obtained two distinct first-order conditions for the maximization problem, one for the interval $a_i \leq \hat{a}$ and the other for the interval $a_i > \hat{a}$. However, in this case different levels of $\hat{a}$ would have implied different marginal monetary payoffs, which instead we want to keep fixed in order to isolate the effect of different minimum contributions.[11]

If individuals were all merely self-interested, minimum recommended contributions would not have any effect for two reasons: first, because the optimal contribution for a self-interested individual is always the null contribution; second, because at the margin the requested minimum contribution cannot affect monetary incentives. Nevertheless, if individual reasons for behavior depart from the traditional assumption of self-interest,[12] some

[9] This probability results from the following procedure: given a group of 6 players, first the group is selected with a probability of 1/2, and then, in the positive case?, one of the six individuals in the group is selected. Notice that the anonymity of the audit is guaranteed.

[10] To conduct the experiment we used the experimental software 'z-Tree' developed by Fischbacher (2007).

[11] It is worth noting that there are cases in the real world in which penalties are applied to those breaking the law and rewards are given to those who abide by the law. For instance, in Italy, penalties (in the form of a reduction in points on the driving license) are implemented for those who violate the Highway Code, while rewards (in the form of more points added to the driving license) are given to those whodo not violate the Highway Code for two consecutive years. This case is very similar to ours, since road safety could easily be thought of as/considered a public good.

[12] A huge amount of empirical and experimental literature shows that in social dilemmas many individuals are driven by social preferences, i.e. having

individuals may make positive contributions (as usually observed in experimental public good games), and minimum recommended contributions might have some effect on individual behavior. Since the structure of our game excludes any possible effect of minimum contribution rules on marginal incentives, any effect needs to be explained on the basis of their behavioral effects.

3.3.2. How do non-binding incentives per se affect cooperative behavior?

In order to answer this question we compare: (a) unconditional contributions in treatment 0 to those in treatment PG; (b) unconditional contributions in H(no-i) to those in H(low-i) and H; and (c) unconditional contributions in H to those in H(low-i). These comparisons allow us to evaluate: (a) the impact of the introduction of incentives to contributions to the public good in the absence of obligations; (b) the impact of the introduction of incentives to contributions to the public good in the presence of a recommended minimum contribution; and (c) the impact of a variation in the level of incentives in the presence of a recommended minimum contribution. As incentives are set at a non-binding level, we expect that varying them will not affect cooperation.

3.3.3. How do obligations and non-binding incentives interact with each other?

To answer this question, we compare contributions in the PG treatment to contributions in the H(no-i), H(low-i) and H respectively. The results of these comparisons help to shed light on the relation between incentives and obligations; in particular, we investigate the role of the presence/absence of incentives in making obligations effective. The question to ask is whether the fact that a contribution is required is enough to exert a behavioral effect, or whether it is necessary to have an incentive structure (though non-binding) for the requirement to have a significant effect. If the latter is the case, we may conclude that incentives not only shape payoffs but they also complement obligations; in particular, non-binding incentives, far from being redundant, play a crucial role in making formal rules work.

3.3.4. What are the channels through which obligations and non-binding incentives affect behavior?

Finally, in order to provide a behavioral interpretation of the possible effect of obligations (incentives) on cooperation, we compare the average beliefs about others' contributions and the conditional contributions in different treatments. We can put forth some conjectures. First, if some individuals are conditional cooperators (Fischbacher et al., 2001; Fischbacher and Gaechter, 2010), i.e. they are willing to cooperate (despite monetary incentives to free-ride) if the other members of their group cooperate to a sufficient extent, minimum contributions may coordinate individuals' beliefs to common focal points, thus affecting cooperative behavior. Second, minimum contributions, being perceived as obligations, may have direct psychological effects on preferences (and thus on behavior) if they affect individual personal contribution norms. If obligations affect beliefs, we expect to observe significant differences in beliefs stated about others' contributions across treatments. If they affect preferences, we expect to find significant differences in the conditional contribution schedules. In particular, if people make different contributions for the same hypothetical average contributions of other group members, it means that preferences for cooperation are directly shaped by the minimum contribution rules.

other-regarding or process-regarding preferences (for a survey on social preferences see Camerer and Fehr, 2002; Fehr and Schmidt, 2002).

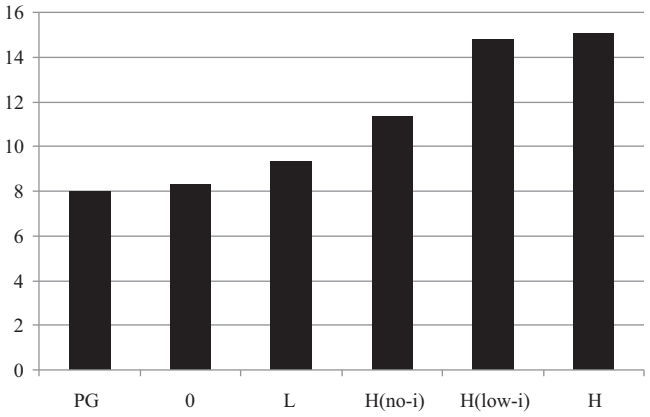

Fig. 1. Unconditional contributions (average contribution in each treatment).

4. Results

4.1. Question 1: How do obligations per se affect cooperative behavior?

In order to answer this question we compare: (a) unconditional contributions in the H(no-i) treatment to contributions in the PG treatment and (b) unconditional contributions in the H, L and 0 treatments respectively.

The first step of our analysis aims to clarify whether variations in the requested minimum contribution significantly affect cooperative behavior. In this respect, we have two possibilities. First, an obligation is introduced in the absence of incentives. Second, an obligation is introduced and varied in the presence of incentives. This analysis provides us with information about whether obligations per se have any effect on behavior and how obligations and non-binding incentives interact. In particular, we try to understand whether the response to a recommended minimum contribution to the public good in the case that there is no incentive structure, differs from the response in the case that there is a non-binding enforcement structure.

In Fig. 1 we report the average unconditional contributions in all the six treatments. Thus, we have an overall picture of the effects of variations in obligations and non-binding incentives on the average cooperative behavior across treatments. In order to better interpret the results on average contributions, we also construct Fig. 2, which represents the cumulative average contributions in all treatments (with average contributions on the horizontal axis and the proportion of individuals on the vertical one).

To investigate how the introduction of a minimum recommended contribution affects donating to the public good in the

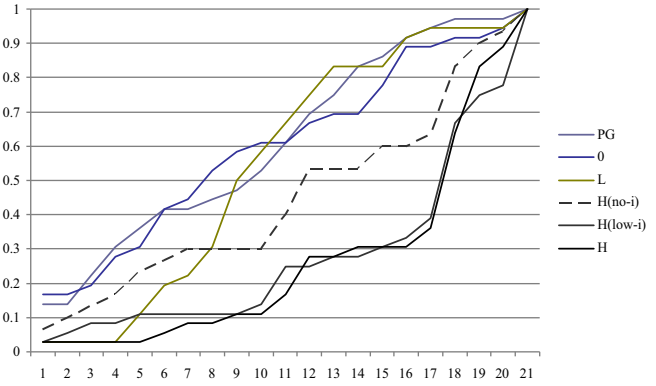

Fig. 2. Unconditional contributions (cumulative average contributions).

Table 2
Test statistics.

	Difference between unconditional contributions	*Z* statistics	*T* statistics
H condition Vs PG	*7.027*	*4.888*	*5.671*
PG vs zero condition	0.277	0.175	0.197
H condition Vs L condition	*5.694*	*4.634*	*5.257*
L condition vs PG	1.333	0.836	1.117
H no incentives vs PG	*3.305*	*2.221*	*2.205*
H condition vs H no incentive	*3.772*	*2.459*	*2.667*
H low inc vs H no inc	*−3.444*	*−2.205*	*−2.290*
H condition vs H low inc	−.2777	−0.023	−0.223
Zero condition vs PG	.2777	−0.175	−0.197

Differences significant at 5% are reported in italics.

absence of a non-binding incentive structure, we initially focus on the PG and on the H(no-i) treatments. The first treatment is the baseline treatment: a one-shot linear public good game without a requested minimum contribution or incentives, coupled with the elicitation of conditional contributions and beliefs. The second treatment introduces a high requested minimum contribution (16 tokens), without a penalty or reward structure. From Fig. 1 we observe that in the PG treatment we replicate the findings in public good experiments that average contributions are positive but far from efficient. In the treatment with a requested minimum contribution, the average unconditional contribution to the public good increases by 41% with respect to the baseline PG treatment (from 8.02 in PG to 11.33 in H(no-i)). Thus, the introduction of a minimum requested contribution per se increases efficiency. Table 2 reports results for mean comparisons between pairs of treatments. As results reported in the table show, to test the statistical significance of the differences in the contributions between two treatments, we run both a Mann–Whitney rank-sum test and a standard *t*-test.[13] Results comparing PG and H(no-i) treatments show that the difference in the average contributions in the two treatments is significant at conventional levels. This shows that suggested obligations affect average contributions to the public good.

To better understand how obligations affect unconditional contributions, we now analyze the effect of different levels of obligation for a given structure of incentives. Looking at the treatment where the obligation is 4 tokens (L) and at the treatment where no minimum contribution is required (0) in Fig. 1, we observe similar levels of average contribution to the public good (9.36 and 8.30 tokens respectively). On the other hand, the average contribution in the treatment where the obligation is 16 tokens (H) is remarkably higher (15.1 tokens) than in the other two treatments. By running a Mann–Whitney rank-sum test and a *t*-test to verify the statistical significance of the differences in contribution levels between the treatments, we find that mean contributions in treatment H are higher at significant statistical levels than mean contributions in both the other treatments, while we do not find a significant difference between the average contributions in the 0 and in the L treatment.

This second result is in line with the findings obtained by Galbiati and Vertova (2008)[14] in a repeated public good game: for given marginal incentives, obligations can affect the average propensity to cooperate for the public good. In particular, when the minimum contribution required is sufficiently high (treatment H), the level of cooperation is significantly higher than in the presence of low or null obligations. Instead, when the minimum contribution required by the obligation is low (treatment L), there is no significant difference with respect to the no-obligation case. A straightforward interpretation of this last result is that with a low obligation, conditional co-operators find confirmation (on average) of their preferences and beliefs when no obligation exists.[15]

This evidence can be summarized as follows:

Result 1. The introduction of a minimum recommended contribution (in the absence of incentives) leads to an increase in the provision of the public good. In the presence of a non-binding incentive structure, average contributions are significantly higher when the minimum contribution required by the obligation is sufficiently higher than the average contributions in the 'no obligation' case.

These results tell us that, ceteris paribus, an increase in the minimum contribution requested positively affects cooperative behavior. Moreover, by observing differences between cooperation levels in the presence and absence of incentives, it emerges that the presence of an incentive structure seems to reinforce the effect of obligations. The next step in our analysis focuses on the effect of ceteris paribus variations in incentives. Afterwards, we will come back to this last observation to analyze how incentives and obligations interact.

4.2. Question 2: Ceteris paribus, how do non-binding incentives affect cooperative behavior?

In order to answer this question we compare: (a) unconditional contributions in treatment 0 to those in treatment PG; (b) unconditional contributions in H(no-i) to those in H(low-i); and (c) unconditional contributions in H to those in H(low-i). These comparisons allow us to evaluate: (a) the impact of the introduction of incentives on contributions to the public good in the absence of obligations; (b) the impact of the introduction of incentives on contributions to the public good in the presence of a recommended minimum contribution; (c) the impact of a variation in the level of incentives in the presence of a recommended minimum contribution. It is worth mentioning that we are not interested in an investigation into the effects of binding incentives: a binding incentives scheme would in fact change the game's payoff structure, and make 'full contribution' a dominant strategy for all players.

We start by analyzing the effect of the introduction of non-binding incentives in the absence of obligations. By comparing the unconditional contributions in the 0 and PG treatments, we can better observe how incentives work. These two treatments are characterized by the absence of a recommended minimum contribution and differ because in the 0 treatment we have a probabilistic reward system, while in the PG treatment there is no incentive to contribute to the public good. We do not observe any significant difference between the unconditional contributions in the two treatments (see Fig. 1). In the absence of obligations, the introduction of weak incentives does not have any effect on cooperative behavior. A comparison between the 'PG condition' and '0 condition' provides us with further insight into the behavioral effect of incentives. Note that the game played in the '0 condition' is a basic linear public good game with a non-binding incentive to contribute. In our case, we observe neither the crowding-in nor the crowding-out of contributions in the absence of obligations. A plausible reason for this result is that, in this case, the incentives are exogenously fixed by a third party with respect to the behavior of others, and

[13] The unit of observation in the statistical tests is individuals.

[14] Galbiati and Vertova (2008) focus on the effect of obligations in a repeated public good game. Unlike this paper, they do not analyze the determinants of the effects of obligations but rather their dynamic effects on cooperation.

[15] Indeed in one-shot public good games with no obligations, average contributions tend to be around 40–50% of the overall endowment because of the behavior of conditional co-operators. See, among others, Fischbacher et al. (2001).

hence they do not provide any information about other peoples' motivations. This suggests that incentives activate or crowd-out social preferences when they are endogenous with respect to group behavior. In this last case, incentives are able to convey relevant information about other people's behavior and intentions.[16]

Our second purpose is to analyze whether there is any difference in average contributions between the treatment with high obligation and no incentives (H(no-i)) and the treatment with high obligation and a very low level of non-binding incentives (H(low-i)). Graphical evidence in Fig. 1 shows that average unconditional contributions are different (11.3 and 14.8 tokens in H(no-i) and H(low-i) respectively: 30% higher in the presence of incentives). A Mann–Whitney rank-sum test and a *t*-test (see Table 2) corroborate the hypothesis of a significant difference in contributions to the public good between the two treatments. This means that, in the presence of an obligation of minimum contributions, even a very small incentive tending to 0 positively shapes cooperative behavior. By comparing the H(no-i) and the H treatment (equivalent to H(low-i) but with higher yet still weak incentives) the same results hold.

Finally, we evaluate the impact of a variation in the level of incentives in the presence of a minimum requested contribution to the public good. To investigate this question we compare unconditional contributions in treatment H, where the probability of the monitoring parameter and the sanction/reward rate are fixed at $p = 1/2$ and $g = 1.2$ respectively, to contributions in treatment H(low-i), where we set the expected sanction (reward) parameters as follows: $p = 1/100$ and $g = 1.2$. In this second case, the monitoring probability is almost only 1/10 of its probability in treatment H and the per-unit reward (sanction) is 0.012 tokens (the monetary equivalent is 1/3 of a eurocent). Graphical evidence in Fig. 1 shows that average unconditional contributions in the two treatments are very close to each other (15.1 and 14.8 in H and H(low-i) respectively). The results of testes reported in Table 2, confirm that we cannot reject the hypothesis that the average unconditional contributions in the two high-obligation treatments are the same at any conventional level.

This evidence can be summarized as follows:

Result 2. The introduction of a non-binding incentive structure in the absence of obligations does not affect contributions to the public good. In the presence of a minimum recommended contribution, the introduction of non-binding incentives induces a significant increase in the provision of the public good. An increase in the level of non-binding incentives in the presence of obligations does not affect average contributions.

Taken together, results 1 and 2 suggest that there is a positive interaction between non-binding incentives and obligations, affecting cooperative behavior. In the next section we further explore this hypothesis.

4.3. Question 3: How do obligations and non-binding incentives interact with each other?

The results of the previous two sessions suggest the existence of a positive interaction between non-binding incentives and obligations, affecting contributions to the public good. In the presence of a high recommended minimum contribution, the introduction of extremely low incentives helps increase contributions. Moreover, the effect of introducing an obligation is stronger in the presence of incentives than in their absence (the difference between unconditional contributions in H and 0 treatments is higher than the difference between PG and H(no-i)). We now further explore this issue. We compare the differences between contributions in the baseline PG treatment and the treatment with obligations without incentives (H(no-i)), to the difference in contributions between PG, H(low-i) and H, where incentives and obligations are both present. We observe that while the simple introduction of an obligation increases contributions by about 40% (H(no-i) vs. PG), the introduction of an obligation jointly supported by non-binding incentives increases contributions by more than 80% (contributions in H(low-i) and H are respectively 84% and 87% higher than in PG).

This means that the effects of obligations on cooperative behavior are much stronger when they are supported by incentives. This result is particularly important as it shows a major alternative role of incentives. Incentives are crucial not only when they can enforce rules by changing people's dominant strategies. From our analysis, a complementary relation between obligations and incentives emerges: obligations are more effective when an incentive is provided, even if this incentive is non-binding with respect to the individuals' payoffs.

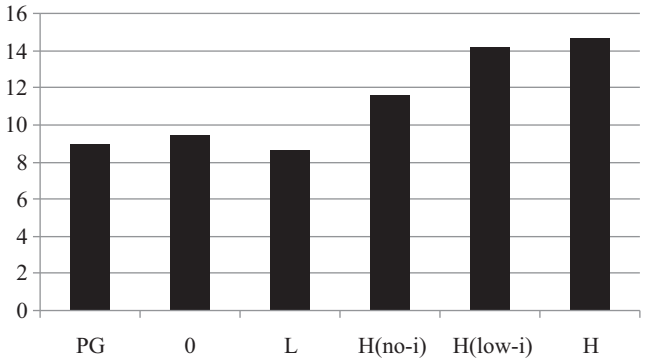

Fig. 3. Beliefs about others' unconditional contributions.

Result 3. Obligations and non-binding incentives are complementary in supporting cooperation in public good games.

The next step in our analysis is to provide some evidence on how obligations and non-binding incentives work in shaping cooperative behavior. Since material payoffs are not affected, other behavioral channels must come into play: we investigate expectations about others' contributions and social preferences.

4.4. Question 4: Channels through which obligations and non-binding incentives affect behavior

4.4.1. Beliefs

Our next step is to study how obligations and non-binding incentives affect beliefs about others' contributions. Fig. 3 shows the average beliefs in all treatments about the average unconditional contributions in the group.

This evidence can be summarized as follows. First, beliefs about others' average contributions are coordinated toward higher levels of expected cooperation, when the minimum level of contribution required by an obligation is higher. Second, non-binding incentives tend to affect individuals' beliefs. Indeed, first order beliefs in the treatment H(low-i) tend to be higher than in the treatment H(no-i) (see Fig. 3; Mann Whitney test implies a: z-stat = −2.250; t-stat = −2.368). Third, obligations and non-binding incentives have a complementary effect on individuals' expectations about others' behavior. In fact, when both obligations and non-binding incentives are present first order beliefs tend to be higher.

In sum, the results on cooperative behavior seem to be valid for our expectations about cooperative behavior. This suggests

[16] This evidence is consistent with the results of Tyran and Feld (2006) showing that exogenous mild sanctions do not anchor contributions in public good games, while endogenously voted mild sanctions affect contributions significantly.

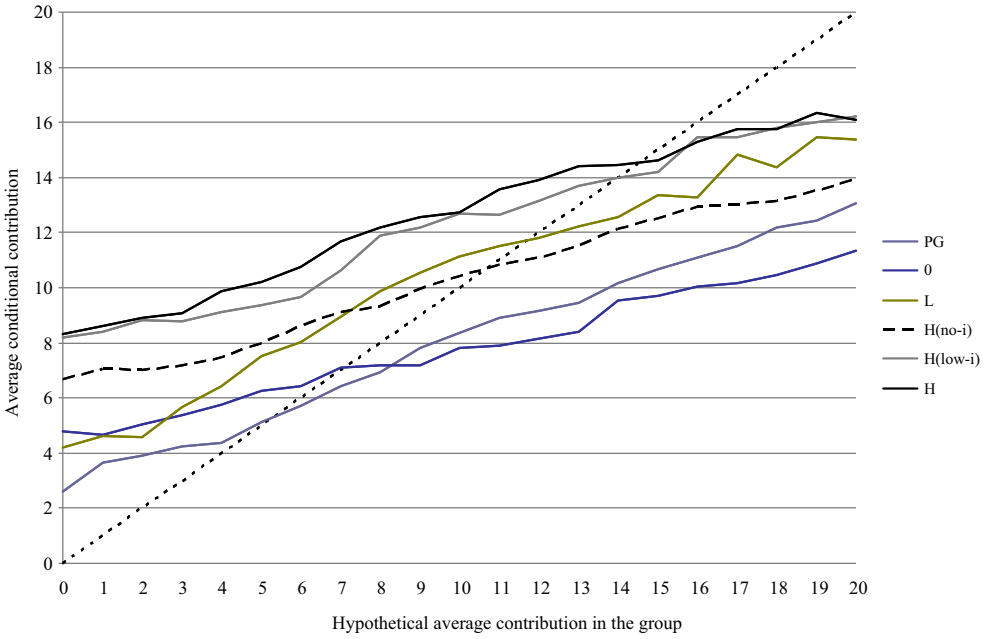

Fig. 4. Conditional contribution schedules.

that the effect of obligations and non-binding incentives on cooperation may be partially triggered by beliefs about conditional co-operators, i.e. people who want to cooperate if they expect others to contribute to a sufficient extent. Result 4 summarizes the evidence on beliefs.

Result 4. Obligations and non-binding incentives affect beliefs about others' unconditional contributions.

4.4.2. Analysis of conditional contributions

We now analyze the patterns of conditional contributions under different conditions. The idea here is that conditional contribution schedules capture the full range of individual strategies to control for beliefs about others' contributions by means of the strategy method (Fischbacher et al., 2001). Significant differences in conditional contribution schedules across treatments would suggest that obligations and non-binding incentives may affect contributions through an effect on motives for behavior other than beliefs about others' contributions.

Fig. 4 reports the patterns of conditional contributions under the six different treatments. The curves corresponding to the 'H condition' and the '0 condition' differ noticeably over the entire interval between 0 and 20. In particular, the conditional contribution schedule corresponding to the 'H condition' is clearly above the one corresponding to the '0 condition'. The 'L condition' curve differs from the other two curves: with respect to the '0 condition' curve the difference is particularly marked in correspondence with high levels of other people's hypothetical average contributions, whereas with respect to the 'H condition' the difference is more relevant for low levels of others' hypothetical average contributions. The differences among the conditional contribution schedules highlight the fact that, even if we control for beliefs about others' contributions by means of the strategy method, average cooperation turns out to be triggered by the level of minimum contribution required by the obligation.

Moreover, where the obligation is not sustained by an incentive, we notice that the conditional contribution schedule in treatment H(no-i) is only slightly higher than in the baseline public good game. Nonetheless, by adding a non-binding incentive structure, we observe a great difference between conditional contribution schedules in the presence and in the absence of an obligation. Finally, we find a relevant difference between schedules in the H(no-i) and H(low-i) cases, suggesting that, in the presence of an obligation, the existence of an incentive, even if non-binding and very small, has a direct effect on individual willingness to cooperate, once we control for beliefs.

To summarize this analysis, our main result is the following:

Result 5. In the presence of higher obligations coupled with non-binding incentives, we observe an upward shift in conditional contributions.

This finding can be interpreted as an indication of the fact that some people have a preference for complying with norms (Lopez-Perez, 2008). Under this view, the introduction of obligations anchors individual preferences for norm compliance.

5. Comments and concluding remarks

Understanding how formal rules affect human behavior is a fundamental task for economic theory and for policy makers. The economics literature has studied extensively the role of incentives in shaping people's choices. Incentives can modify the payoffs for individuals' actions, thus inducing the desired behaviors. Nonetheless, formal rules are often backed by weak incentives. Deviations from behaviors recommended by formal rules are characterized either by low probabilities of monitoring, or small sanctions for undesired behaviors. Despite such a widespread presence of weak incentives, people often abide by the rules.

Explaining why people comply with rules in the presence of weak incentives is a major puzzle in economics. Other disciplines, such as legal theory and social psychology, suggest that obligations, that is to say the normative contents of rules, play a crucial role in driving individuals' behavior. Yet, we still know very little about how obligations affect behavior, and how they interact with the incentives part of a rule. In this paper, by running a series of modified public good games, we have contributed to clarifying these issues, thus providing a more complete view of how formal rules work.

We have found that obligations have a sizeable effect on cooperative behavior, even in the absence of incentives. When

Table A1
Paired lottery choices.

Option A	Option B	Payoff differences (A-B)
1/10 100 tokens; 9/10 80 tokens	1/10 170 tokens; 9/10 10 tokens	56
3/10 100 tokens; 7/10 80 tokens	3/10 170 tokens; 7/10 10 tokens	28
5/10 100 tokens; 5/10 80 tokens	5/10 170 tokens; 5/10 10 tokens	0
7/10 100 tokens; 3/10 80 tokens	7/10 170 tokens; 3/10 10 tokens	−28
9/10 100 tokens; 1/10 80 tokens	9/10 170 tokens; 1/10 10 tokens	−56

non-binding incentives are introduced, requested contributions strongly sustain cooperation. Our results suggest that, in public good situations, obligations and non-binding incentives are complementary, jointly supporting high levels of contributions. Since in our framework the incentive structure does not modify material payoffs, this means that, combined with an obligation, incentives crowd-in reasons for behavior other than self-interest in sustaining cooperation. One potential criticism of this interpretation relates to the Prospect Theory. Despite incentives never being binding in our treatments, when we introduce incentives in the absence of obligations, they only take the form of rewards (i.e. the presence of an incentive does not involve the danger of a loss). However, if incentives are introduced in the presence of obligations, then they come in the form of both rewards and punishments, so that the danger of a loss is introduced. Thus, in principle, incentives may affect behavior not only by reinforcing the salience of norms, but also by introducing the possibility of losses. However, the H(Low-i) treatment shows that even very weak incentives (a detection probability of 1/100) reinforce the impact of obligations on contribution behavior. In this case, the explanation related to loss aversion is not very likely: where punishment is so improbable, it is not really plausible that the behavioral changes are caused by the fear of loss.

Furthermore, through a strategy based on the elicitation of beliefs and conditional contributions to the public good, we have found that the effect of obligations on behavior depends not only on their impact on people's beliefs about others' contributions, but also on their direct effect on individual willingness to cooperate.

These results add to the literature on the effects of institutions on behavior in two ways. First, they support the idea that formal rules and laws have an expressive power: they can affect behavior not only by shaping material payoffs for individuals, but also by directly influencing people's motives for behavior (Cooter, 2000) and by acting as focal points (McAdams, 2000). Second, they suggest some important behavioral effects of incentives. Our experimental results show that incentives may affect cooperative behavior not only by changing payoffs, but also by complementing obligations.

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Table A2
Risk preferences associated to lottery choices.

Sequence of choices	Risk type
A-A-A-A-A	Highly risk averse
A-A-A-A-B	Risk averse
A-A-A-B-B or A-A-B-B-B	Risk neutral
A-B-B-B-B	Risk lover
B-B-B-B-B	Highly risk lover
Other sequences	Inconsistent choices

Table A3
Frequencies of subjects by class of risk preferences.

Class of risk preferences	0 condition (MC = 0)	L condition (MC = 4)	H condition (MC = 16)
Highly risk averse	6	1	2
Risk averse	5	3	6
Risk neutral	14	23	16
Risk lover	1	2	0
Highly risk lover	1	1	1
Inconsistent choices	9	6	11

Appendix 1. Controlling for differences in risk preferences

In order to control for the possible effect of risk preferences, at the end of the public good experiment we run a lottery to single out the subjects' risk preferences. This lottery is similar to that implemented by Holt and Laury (2001). The experimental test is based on five choices between the paired lotteries reported in Table A1.

In each paired lottery, subjects choose between an alternative A and an alternative B. Once all the subjects have made their choice, a pair of lotteries is randomly chosen and the computer assigns to each subject the option (A or B) they have chosen. Finally the lottery is run in order to determine each subject's payoff. Following the method proposed by Holt and Laury (2001), we classify individual risk preferences according to the sequence of choices taken in the lottery (see Table A2).

In Table A3 we report the frequencies of subjects by classes of risk preference in the three treatments with different levels of obligation.

It is worth noting that the frequencies are similar across the different samples. Furthermore, we notice that the number of risk-lover or highly risk-lover individuals is very small.

In order to test whether or not differences in risk preferences are relevant in explaining differences in contributions, we subdivide our sample into three groups: the first group is composed of risk-neutral individuals, the second is composed of risk-adverse individuals and the third one of highly risk-averse individuals.[17] Moreover, for each subject we compute an index given by the

[17] We have not considered risk-lover or highly risk-lover individuals, who represent a negligible fraction of subjects in the sample, nor individuals whose choices are inconsistent.

difference between their unconditional contribution and the minimum contribution required in the treatment. We then apply a Mann–Whitney rank-sum test[18] of the difference in this index between each pair of groups. The test between risk neutral and highly risk-averse individuals yields $z = -1.295$, which is not statistically significant at conventional levels. Applied to the difference in this index between risk-neutral and risk-averse individuals, the same test yields $z = -0.627$, which is certainly not statistically significant. Finally, the difference between highly risk-averse and risk-averse individuals is also found to not be statistically significant ($z = -0.539$).

Hence, differences in subjects' risk preferences across the different samples do not affect our results for two reasons. First, the distribution of subjects by class of risk preference is very similar in the different sessions. Second, there is no significant difference in individual behaviors, with respect to the minimum contribution, between highly risk-averse, risk-averse and risk-neutral individuals. This last result can be explained by the fact that the probability of being audited in each round and the penalty rate are both very low.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.irle.2014.03.001.

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[18] The unit of observation in the statistical test is the individual.