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# Conditional Cooperation in a Linear Public Goods Game

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## **Abstract**

This paper presents data from a public goods experiment where subjective beliefs on the behaviour of others were not elicited. Instead, three widely used definitions of expectation formation were employed in order to investigate the theory of conditional cooperation in general and the existence of types in particular. On basis of first round contributions, participants were either classified as conditional cooperators or as free riders. The results indicate that both, adaptive and naive expectations are consistent with reciprocal behaviour of the aggregate and importantly, also with the hypothesis that first round contributions signal cooperative disposition. Individuals that were classified as conditional cooperators displayed a higher degree of responsiveness than free riders. This ordering holds true for both expectation formation algorithms. While this finding is remarkable, the study also pointed out deficiencies of the categorisation approach. A detailed analysis of individual heterogeneity reveals that conditionally cooperative behaviour alone may fall short of explaining observed behaviour of non-free riders. A non-negligible fraction of participants exhibited unconditionally cooperative behaviour.





# 1 Introduction

Goods that are characterised by non-excludability and non-rivalry do not conform to the assumptions needed for a competitive economy to be efficient (see e.g. Samuelson, 1954). Whilst equating marginal benefits and costs unambiguously satisfies the concept of individual rationality, collective rationality is impeded by this very principle in the presence of strategic interaction. Linear public good games are typically designed in order to display this tension between individual and mutual rationality: Marginal costs of providing the public good exceed the associated marginal individual benefits. The logic of self-interest therefore suggests to abstain from contributing and to rely on the provision of others instead. However, experimental evidence is at odds with the Nash-prediction of free-riding.

Reviewing the experimental literature until the mid 1990s, Ledyard (1995) provides two stylised facts: (1) In one-shot versions of the voluntary contribution mechanism (VCM), participants contribute between 40% and 60% of their total endowment. (2) In finitely repeated versions of the VCM contributions decline steadily over time while the equilibrium of full free-riding is not quite reached. The actual level of cooperation is influenced by a variety of factors such as the group size (Isaac, Walker, and Arlington, 1994), the marginal per capita return (MPCR) (Isaac and Walker, 1988), whether participants change groups randomly from round to round or whether they stay in the same group for all periods (Keser and van Winden, 2000).

At first, economists sought to reconcile these results with game theory by rationalisations that are consistent with the paradigm of the self-interested pecuniary maximiser. Andreoni (1988, 1995) and Isaac and Walker (1988) interpret cooperative behaviour as an erroneous decision of subjects who misunderstand the instructions or the incentives in the experiment.<sup>1</sup> The decay in contributions is consequently attributed to learning. In a subsequent paper, Andreoni (1988) suggests that initial cooperative behaviour may be part of a multi-period strategy. While some controversy about the relevance of these hypothesis remains (see e.g. Muller, Sefton, Steinberg, and Vesterlund, 2008), a fair amount of studies conclude that neither *confusion* and *learning* nor *strategic play* alone can be supported as explanations of decay in public goods games (see e.g. Neugebauer, Perote, Schmidt, and Loos, 2009).

Researchers therefore turned to theories of 'non-standard' behaviour, i.e. behaviour which is not motivated by pecuniary payoff maximisation alone. Andreoni (1989, 1990) suggests that individuals may benefit from the consumption of others (altruistic preferences) or from the mere act of giving (warm-glow preferences). However, as pointed out by Gächter (2006), other-regarding preferences of this kind do not provide an explanation for the decay of contributions over time. Note, moreover, that confusion and learning as well as altruism and warm-glow preferences are motivations which are independent of the behaviour of others. This conclusion,

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<sup>1</sup>Andreoni reckons that a Nash prediction of zero contribution allows confused subjects to err only in one way - namely by contributing too much. If, on the other hand, the game featured an interior equilibrium, errors were likely to be averaged out.

however, is inconsistent with experimental evidence.

A solid body of research suggests that the behaviour of others matters for individual choice. Specifically, most participants in linear public good games are willing to cooperate given that their group members cooperate as well. These subjects are referred to as *conditional cooperators*. While the notion of conditional cooperators suffices to explain non-zero initial contributions (under appropriate assumptions on initial expectations), the decay in contributions can be rationalised on grounds of the following two refinements. First, there appears to exist a second 'type' of player - the *free-rider*. Between 6% (Herrmann and Thöni, 2009) and 30% (Fischbacher, Gächter, and Fehr, 2001) of participants in public good experiments are, in accordance with the classical theory, entirely relying on the contributions of their group members. Second, conditional cooperators do not mirror experienced behaviour one by one. Instead, there appears to exist a selfish-bias in their conditional cooperation (Neugebauer et al., 2009). The interaction of free riders and selfish-biased conditional cooperators reasonably well explains observed behaviour.<sup>2</sup>

The present research examines identifiability of types. In particular, the hypothesis is tested whether first round contributions, in a repeated public goods game, reveal cooperative dispositions. In contrast to recently published papers (see e.g. Fischbacher, Gächter, and Quercia, 2012), individual expectations of the average group contribution are not elicited explicitly in order to avoid priming and anchoring effects.<sup>3</sup> However, given that expectations are not formed in an arbitrary way, the theory of conditional cooperation can be tested nonetheless. This paper employs three well established expectation formation algorithms in order to draw conclusions on basis of behavioural data.

This paper proceeds as follows: Section 2 gives an overview of related literature. Thereafter, the research hypothesis and the modelling approach are presented in section 3. The experimental design and the results are presented in section 4. Section 5 concludes.

## 2 Related Literature

### 2.1 Conditional Cooperation

Sugden (1984) was among the first to draw attention on social interaction effects in the provision

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<sup>2</sup>Note that the theoretical relevance of reciprocity is not specific to the literature on public goods. Analog arguments have been used to explain cooperation in prisoner's dilemma situations (Axelrod, 1984), contract enforcement (Fehr et al., 1997) and the low amount of income-tax evasion (Bordignon, 1993). Frey and Torgler (2007) investigate survey data from 30 West and East European countries and conclude that conditional cooperation is an important determinant of tax evasion.

<sup>3</sup>The theory of priming (see e.g. Drouvelis and Metcalfe, 2010) suggests that the mere enquiry about the expected contribution by others might influence the decision process and in particular, increase the impact of other's (expected) behaviour. Instead, the accuracy of categorisation is evaluated by means of a behavioural analysis in conjunction with assumptions on the process of expectation formation.

of public goods. He suggests that people follow a morality of cooperation rather than a morality of altruism and argues for a principle of reciprocity which acts as a constraint on individual maximisation.<sup>4</sup> According to this principle, the moral justification of free-riding and hence its prevalence, crucially depends on the behaviour of others. Individuals may not free-ride without costs when others are contributing to the public good. Recently, formal theories of reciprocity have been provided by Falk and Fischbacher (2006), Cox, Friedman, and Gjerstad (2007) and Cox, Friedman, and Sadiraj (2008).

Keser and van Winden (2000) introduced the notion of conditional cooperation in course of demonstrating the importance of reciprocity in a linear public goods experiment. They showed that individual behaviour is oriented towards the average behaviour of the other group members. Croson (2007) was among the first to directly elicit beliefs about the contribution of other group members. The results of her experiments display a positive and significant correlation between an individual's own contribution and his or her beliefs about the contributions of others. Fischbacher et al. (2001) and Neugebauer et al. (2009) reaffirm the prevalence of conditional cooperation in public good games whilst drawing attention to an important subtlety: Individuals exhibit a selfish-bias in their conditional cooperative tendencies. Since contributions increase less than fully proportional with those by others, aggregate contributions are condemned to decay. Note that Neugebauer et al. as well as Croson did not analyse individual behaviour. Their observation is that people are conditionally cooperative on average.

However, Chaudhuri (2011) reckons that the recognition of distinct types is one of the major advances that have been made in the understanding of public good games during the last decade. The analysis of individual heterogeneity (see e.g. Fischbacher et al., 2001; Burlando and Guala, 2005; Fischbacher and Gächter, 2006) indicates that there exist at least two types of players: participants whose contribution schedule is an increasing function of the average contribution of others - commonly referred to as conditional cooperators - and participants whose strategy is to always contribute zero - free riders.<sup>5</sup>

## 2.2 Heterogeneity in Behaviour

An important contribution with respect to the analysis of individual heterogeneity was made by Fischbacher et al. (2001) who introduced a variant of the "strategy method" (Selten, 1967) to infer on individual contribution preferences as a function of other group members' average contribution. The method involves asking subjects about their desired contribution conditional on each possible average contribution of the other group members. The effect of potentially

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<sup>4</sup>Note that psychologists have long argued for the importance of reciprocity (see e.g. Kelley and Stahelski, 1970)

<sup>5</sup>In addition to conditional cooperators and free-riders, Fischbacher et al. (2001) and Fischbacher and Gächter (2006) also identified more "exotic" contribution schedules of triangle contributors. The contribution schedule of this type of player is a non-monotone, concave function of others' average contribution.

biased beliefs is thus eliminated.<sup>6</sup>

Individual contribution schedules enable Fischbacher and Gächter (2010) to define types by means of the parameters in a linear regression: The contribution schedule of a free rider consists of zero's for all contribution levels of the other group members. Both, the intercept and the slope in a linear regression of individual contribution on other's contribution are therefore zero. A perfect conditional cooperator, on the other hand, is characterised by the element (0,1) in the two dimensional intercept-slope space since individual contributions increase one-by-one with other's contributions. In a within-subject design, Fischbacher et al. (2012) investigate the predictive validity of the strategy method and conclude that observed behaviour in a public goods game, played in the direct response method, is consistent with cooperation preferences elicited through the strategy method.

The classification of players according to their cooperative disposition is nothing new to the literature on public good games and various classification schemes have been proposed. Roughly, these approaches can be divided into two categories. The first category includes studies assessing cooperative disposition in one game in order to predict behaviour in a subsequent, possibly qualitatively different game. Burlando and Guala (2005) classify subjects by combining four sources of evidence for cooperative disposition: the Strategy method, the Decomposed Game Technique (Offerman, Sonnemans, and Schram, 1996), a linear public goods game and a questionnaire. The authors then show that the overall level of cooperation can be raised by forming homogeneous groups of players with similar attitudes towards cooperation. Note that studies in this category implicitly assume consistency of motivations across games.<sup>7</sup>

Studies in the second category circumvent possible inconsistencies of motivations by using one and the same game for classification and investigation. Ones and Putterman (2004) identify types by allowing participants to play a contribution and punishment game for five periods in groups of similarly diverse composition. These "diagnostic" periods are then used to predict behaviour in a subsequent game. While Gunthorsdottir, Houser, and McCabe (2007) pursue a similar goal, namely to analyse behaviour in deliberately composed groups, their classification approach is less sophisticated. Each round participants are ranked according to their latest contribution to the public good. Groups of likewise players are then formed on basis of these ranks.

Clearly, a crucial assumption, underlying these studies, is that subjects bring a stable cooperative

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<sup>6</sup>Gächter (2006) notes that the strategy method circumvents three problems that may arise when the correlation between beliefs and contributions are used as an indicator of conditional cooperation: (1) Beliefs evolve endogenously and are therefore beyond the control of the experimenter, implying that (2) free-riders and pessimistic conditional cooperators are observationally equivalent. (3) Beliefs may reflect a *false consensus* effect, i.e. people may project their own behavioural tendencies unto the behaviour of others.

<sup>7</sup>Blanco et al. (2011) investigate the inequality aversion model of Fehr and Schmidt (1999) across five qualitatively different games. Although the model works reasonably well at the aggregate level, suggesting that game-specific motivations such as altruism, negative-reciprocity and positive-reciprocity are qualitatively captured by the model, the authors find that its predictive power by and large fails at the individual level. Blanco et al. argue that this result may be attributable to the low correlation of different motivations across games.

disposition which can be unveiled through suitable manipulation.<sup>8</sup> Gunnthorsdottir et al. (2007), explicitly addressing this assumption, argue that first period contributions could reveal the type of a player. Using a cut-off rule of 30%, they demonstrate that it is indeed appropriate to classify subjects based on their initial contributions as either free riders or cooperators. Isaac and Walker (1988) were the first to propose contribution-based categorisations and used a cut-off value of 33% of initial endowments. Bigoni and Suetens (2012), studying the effect of feedback in public good games, refer to participants who contribute less than 50 percent of their initial endowment as low contributors while those contributing at least 50% are referred to as high contributors.

### 3 Theoretical Approach and Research Hypothesis

The present research investigates the question whether initial contributions signal cooperative disposition in linear public good games. Since the distinction between types can be regarded as a refinement of the theory of conditional cooperation, the research hypothesis takes a hierarchical structure. In a first step, the consistency of conditional cooperation and three assumptions on expectation formation will be studied. In a second step, the distinction of types is studied. To introduce the theoretical foundations, consider the following standard one-shot linear public good game.

#### 3.1 Public Goods Game

Each player  $i$  in a group of  $N$  identical players is endowed with an income  $I$  which can either be invested in a group account or consumed privately. Denoting player  $i$ 's investment to the group account by  $y_i$ , the payoff from private consumption is given by  $I - y_i$ , i.e. the amount consumed privately. The return from the group account is a multiple  $\delta$  of the sum of individual contributions which is distributed equally among the  $N$  group members. Player  $i$ 's total payoff is therefore given by

$$\pi_i = I - y_i + \frac{\delta}{N} \sum_{j=1}^N y_j. \quad (3.1)$$

There is a pure public goods problem whenever  $1/N < \delta/N < 1$ . Since marginal benefits from contributions to the public good fall short of the associated marginal costs in this case, payoff maximisation suggests to not engage in the provision of the public good and to rely on the provision of others instead.

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<sup>8</sup>Evidence on the stability of individual cooperative preferences is provided by Volk et al. (2012) who identify the Big-five dimension Agreeableness (Costa and McCrae, 1992) as a psychological correlate of cooperation preferences.

Sugden (1984) was the first to consider this game in light of a psychological construct. He suggests that the maximisation of (3.1) is constrained by a principle of reciprocity. Specifically, the principle says that each individual has a moral obligation to contribute the minimum of (1) the least contribution of the other players in his group and (2) the level of contribution he would most prefer that every member of his group makes.<sup>9</sup> This reasoning provides a straight-forward rationale for a positive correlation between individual contributions and the contribution of other group members.<sup>10</sup>

For clarity of the following discussion, let  $y_{it}$  denote individual  $i$ 's contribution to the public good in round  $t$  and  $x_{it} = (N - 1)^{-1} \sum_{j \neq i} y_{jt}$  be the average contribution of player  $i$ 's group members (exclusive of  $i$ ). Theories of reciprocity have straight-forward implications for the linear model

$$y_{it} = \alpha + \beta_i x_{it}^e + \mu_i + \epsilon_{it}, \quad (3.2)$$

where  $\alpha$  is an intercept,  $x_{it}^e$  is some, possibly non-rational, expectation of  $x_{it}$ , individual heterogeneity is accounted for by  $\mu_i$  which satisfies  $\mathbb{E}(\mu_i) = 0$  and  $\epsilon_{it}$  is an independently identically distributed (iid) random variable satisfying  $\mathbb{E}(\epsilon|x) = 0$ . Note that expectations are used in equation (3.2) rather than actual realisations of the variable since, typically, the behaviour of the other group members is not given at the time individual choices have to be taken. A notable exception depict games which are played in the Strategy method.

Reciprocal behaviour in public good games manifests itself in (3.2) through  $\beta_i > 0$ . In this case, expected behaviour of the other group members is, to some degree, accounted for in individual choice. This positive correlation between expectations of the other's behaviour and individual choice will sometimes be referred to as the Null-hypothesis. In order to operationalise this hypothesis, further assumptions on expectation formation are needed. Remember that  $x_{it}^e$  is not known to the experimenter but captures individual expectations.

A number of studies (see reference above) elicited participants' beliefs about the behaviour of their group members so that a direct test of the theory of conditional cooperation was made possible. However, it is argued here that this approach possibly alters behaviour. In particular, the mere interrogation of beliefs might increase the awareness of one's dependency on the behaviour of others and thus induce a more pronounced response to it. By acknowledging that beliefs of

<sup>9</sup>Formally, the principle implies that individual  $i$  maximises  $\pi_i$  subject to the constraint  $x_i \geq \min(x_i^c, x_j \forall j \in N)$ , where  $x_i^c$  denotes optimal contributions of player  $i$  under commitment theories, i.e.  $x_i^c$  is a solution to maximising  $\pi_i$  subject to  $x_j = x_i$  for all  $j$ . Sugden shows that whenever there is a pure public goods problem, the optimal contribution is given by  $x_i^* > 0$ . Moreover, it can be that  $\partial x_i^* / \partial x_j > 0$ , i.e. the optimal contribution is increasing in the contribution of others. See Result 4 of Sugden (1984) for a proof.

<sup>10</sup>Note that Sugden's theory concentrates on the outcomes of choice alone and is thus purely economical in flavour. Falk and Fischbacher (2006), on the other hand, highlight the importance of psychological appraisal. The authors regard reciprocity as a behavioural response to an action which is perceived as either kind or unkind. That is, intentions are a crucial ingredient in this model. Their approach is to transform a standard game into a psychological game, the so-called 'reciprocity game', where utility depends on both, material payoffs and *reciprocity utility*.

participants are not formed in an arbitrary way but intimately related to observable variables, this paper argues that the relevance of conditional cooperation can be tested whilst abstaining from an elicitation of beliefs.

Specifically, the approach followed in this paper is to replace a proxy of expectations (elicited beliefs) with assumptions on the way expectations are formed. Since it is not clear how subjects form their expectations in the current context, i.e. which assumption on expectation formation are most plausible, three hypotheses, differing in their degrees of sophistication, are considered.

### 3.2 Expectation Formation

The most basic approach assumes that expectations are formed in a *naive* or static way (Ezekiel, 1938). That is, expectations of current variables are simply equal to the latest observed value:

$$x_t^e = x_{t-1}. \quad (3.3)$$

While this assumption certainly oversimplifies the process of expectation formation in a more general context, it depicts an interesting benchmark case in the current one for two observations. First, beliefs on the behaviour of group members were not elicited explicitly. Second, all participants in our experiment were inexperienced subjects. On the one hand, these observations suggest that participants might not spend disproportionate effort in finding an optimal prediction. Expectations might be formed implicitly and may thus be largely affected by recent outcomes. Moreover, even if expectations were formed consciously, the latest observation of others' choice might still entail a valuable point of reference for predicting the behaviour of strangers in a game which has not been played before. The first hypothesis is summarised as follows:

**Hypothesis 1 (Naive Expectations and Conditional Cooperation)** *Behaviour of participants in linear public good games can be described in terms of (3.2), where  $\beta_i > 0$  and expectations are given by (3.3).*

An alternative specification of expectation formation, due to Nerlove (1958), assumes that expectations are updated according to

$$x_t^e = x_{t-1}^e + \lambda(x_{t-1} - x_{t-1}^e), \quad (3.4)$$

where  $\lambda \in (0, 1)$ . This algorithm assumes that each period expectations are revised in order to account for the latest observed forecast error, i.e. the discrepancy between actual and expected behaviour of the other group members.<sup>11</sup> The charm of *adaptive* expectations lies in the generality

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<sup>11</sup>Note that Neugebauer et al. (2009) explicitly elicited beliefs which they then modelled in a way that is consistent with the assumption of adaptive expectations.

of its formulation. Depending on the choice of  $\lambda$  the algorithm allows for various interpretations.<sup>12</sup> Clearly, the arbitrariness of  $\lambda$  can also be regarded as a weakness of the algorithm. The second hypothesis is summarised by:

**Hypothesis 2 (Adaptive Expectations and Conditional Cooperation)** *Behaviour of participants in linear public good games can be described in terms of (3.2), where  $\beta_i > 0$  and expectations are given by (3.4).*

The third expectation formation hypothesis considered in this paper, originally proposed by Muth (1961), assumes that expectations are centred around the actual realisation of the variable, i.e. that expectations are optimal in a statistical sense:

$$x_t^e = x_t + \nu_t \tag{3.5}$$

where  $\nu_t$  is an iid random variable with  $\mathbb{E}(\nu|x) = 0$ . So-called *rational* expectations assume the highest degree of sophistication in expectation formation on part of the participants. In the current context this assumption appears implausible for the same observations mentioned in order to justify naive expectations. However, in light of the prevalence of rational expectations in the economics literature, assumption (3.5) also depicts an interesting benchmark case. This leads to

**Hypothesis 3 (Rational Expectations and Conditional Cooperation)** *Behaviour of participants in linear public good games can be described in terms of (3.2), where  $\beta_i > 0$  and expectations are given by (3.5).*

The previously stated hypothesis are formulated for the aggregate. However, the working hypothesis of this research is that there exist two, well distinguishable, types of players.

### 3.3 Types and Cut-Off Rule

Conditional cooperators, on the one hand, are driven by some form of reciprocity. Free riders, on the other hand, are motivated by pay-off maximisation alone. In terms of (3.2), this hypothesis can be summarised by specifying

$$\beta_i = \theta_i \beta, \tag{3.6}$$

where  $\beta > 0$  and  $\theta_i = 0$  if subject  $i$  is a free rider and  $\theta_i = 1$  if subject  $i$  is a conditional cooperator. Note furthermore that Fischbacher and Gächter's description of types implies that the intercept  $\alpha$  is zero for both, conditional cooperators and free riders. Since the present study

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<sup>12</sup>While naive expectations are modelled by choosing  $\lambda = 1$ , expectations are said to be autonomous for  $\lambda = 0$ . For all intermediate values, the algorithm is equivalent to an weighted average of all past observations with geometrically decreasing weights.



concentrates on the identification of types, this restriction is not considered in formulating the hypothesis.

Types may be distinguished on grounds of first round contributions given that the following two assumptions apply: (1) Initial expectations are homogeneous across types, i.e.  $x_{i1}^e$  is identically distributed across  $i$ , and (2) the first moment of initial expectations is strictly positive, i.e.  $\mathbb{E}x_{i1}^e > 0$ . Then it holds that  $\mathbb{E}y_{i1} \leq \mathbb{E}y_{j1}$  for  $i$  being a free rider, i.e. free riders will on average contribute a smaller amount of their initial endowment under the Null hypothesis. Both assumptions are supported by experimental results. Evidence for homogeneous beliefs across types is provided by Fischbacher et al. (2012).<sup>13</sup> Non-zero initial expectations are confirmed by Neugebauer et al. (2009) and Fischbacher et al. (2012).

Furthermore, these studies indicate that participants expect, on average, the other group members to contribute around 50% of their initial endowment. Perfect conditional cooperators and free riders should consequently be expected to contribute around 50% and 0%, respectively, of their initial endowment. However, it was previously mentioned that a number of studies report on selfish-biased behaviour of conditional cooperators, i.e.  $\beta < 1$ . This implies a contraction of the interval of theoretically possible cut-off rules to distinguish between these two types.

Based on these considerations this research establishes the following rule. Participants who contribute less than 1/3 of their initial endowment are categorised as free riders. The other participants will be referred to as conditional cooperators. While any cut-off rule is necessarily arbitrary, to some degree, the clear-cut prediction of the theory suggests that the effect of this arbitrariness on the results will be limited. A conclusion which is affirmed by Gunthorsdottir et al. (2007). The last hypothesis is summarised as follows:

**Hypothesis 4 (Existence of Types)** *There exist two types of players in linear public good games whose behaviour is driven by different motivations. As a consequence, the contribution decision of one type - free riders - is not correlated with the expected contribution of their group members ( $x^e$ ) while the contribution decision of the second type - conditional cooperators - is correlated to  $x^e$ . Moreover, these types can be distinguished on grounds of their initial contribution: Subjects contributing at least 1/3 of their initial endowment belong to the group of conditional cooperators while participants contributing less than 1/3 of their initial endowments belong to the group of free riders.*

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<sup>13</sup>Participants that were categorised as free riders in Fischbacher et al. (2012) indicated, on average, that they expected the others to contribute 46.05% of their initial endowment. The corresponding belief of conditional cooperators amounted to 49.4% and was not significantly different from the former.

### 3.4 Estimation Approach

By combining the assumption of naive expectations (3.3) with the projection (3.2), it is easily seen that Hypothesis 1 implies the regression model

$$y_{it} = \alpha + \beta_i x_{i(t-1)} + w_{it}, \quad (3.7)$$

where the composite error  $w_{it} = \mu_i + \epsilon_{it}$  is the sum of the unobserved effect and an idiosyncratic error. Note that in a partners matching design, that is, when groups do not change throughout the experiment,  $x_{i(t-1)}$  does not satisfy a strict exogeneity assumption in (3.7) since it is correlated, by definition, with  $y_{i(t-2)}$  under the Null hypothesis.<sup>14</sup> In other words, conditional cooperation implies that  $i$ 's group decision in period  $t$  is affected by  $i$ 's choice one period before. Furthermore, this correlation implies a violation of contemporaneous exogeneity, since  $x_{i(t-1)}$  and  $w_{it}$  must be correlated through the individual fixed effect, and thus inconsistency of Ordinary Least Squares (OLS).

However, in the current context the correlation between  $x_{i(t-1)}$  and  $y_{i(t-2)}$  should be negligible since groups are randomly recomposed each period. The assumption that  $i$ 's group members' (exclusive of  $i$ ) average choice in period  $t$  is not significantly affected by  $i$ 's choice in period  $t - 1$  will be maintained throughout this section. Under naive expectations, this assumption implies strict exogeneity of the regressors. Equation (3.7) can therefore be efficiently estimated by making use of the known error structure, i.e. by random effects estimation.

Adaptive expectations (3.4) together with (3.2) imply the autoregressive distributed lag model

$$y_{it} = \alpha\lambda + (1 - \lambda)y_{i(t-1)} + \beta_i\lambda x_{i(t-1)} + w_{it}, \quad (3.8)$$

where  $w_{it} = \mu_i + \epsilon_{it} + (1 - \lambda)\epsilon_{i(t-1)}$ . To consistently estimate the parameters in (3.8) two complications have to be accounted for: Individual heterogeneity, i.e. the presence of the unobservable component  $\mu_i$  and endogeneity, i.e. the correlation between regressors and the error term. In order to eliminate individual fixed effects, the equation can be first-differenced so that  $\mu_i$  drops out of the equation. Clearly, this does not resolve the problem of endogeneity since  $\Delta y_{i(t-1)}$ , one regressor of the first-differenced equation in period  $t$ , is contemporaneously correlated with the first-differenced error term  $\Delta w_{it} = \epsilon_{it} - \lambda\epsilon_{i(t-1)} - (1 - \lambda)\epsilon_{i(t-2)}$ .<sup>15</sup>

However, note that contributions to the public good lagged for three periods or more are uncorrelated to  $\Delta w_{it}$ . If, moreover, there is sufficient persistence in the first-differenced process of

<sup>14</sup>By definition  $x_{it} = (N - 1)^{-1} \sum_{j \neq i} y_{jt}$ . Under naive expectations  $y_{jt} = \alpha + \beta_j x_{j(t-1)} + w_{j(t-1)}$ . Combining these two expressions and making use of the definition of  $x_{j(t-1)}$  once more shows that  $x_{it}$  is a function of  $y_{i(t-1)}$ . This implies that  $x_{it}$  is correlated with  $y_{i(t-1)}$  and therefore also with  $w_{i(t-1)}$ . Strict exogeneity of a regressor  $x$  requires that  $Cov(x_{it}, w_{it^*}) = 0$  for all  $t, t^*$ , which is clearly violated in this setup.

<sup>15</sup>This can be seen by noting that  $\Delta y_{i(t-1)} = (1 - \lambda)\Delta y_{i(t-2)} + \beta_i\lambda\Delta x_{i(t-2)} + \Delta w_{i(t-1)}$ . Thus, it holds that  $Cov(\Delta y_{t-1}, \Delta w_{it}) = \sigma^2(2\lambda - 1)$ , where  $\sigma^2 = Var(\epsilon)$ . Consequently,  $\Delta y_{t-1}$  will be correlated with  $\Delta w_{it}$  unless  $\lambda = 1/2$ .

individual contributions such that  $y_{i(t-1)}$  is correlated with  $y_{i(j-1)}$  for all  $j < t$ , lagged contributions can be used as instruments for contemporaneous first-differenced contributions.<sup>16</sup> These considerations suggest GMM estimation along the lines of Arellano and Bond (1991).

Combining the assumption of rational expectations (3.5) with (3.2) yields the regression model

$$y_{it} = \alpha + \beta_i x_{it} + w_{it}, \quad (3.9)$$

where the composite error is given by  $w_{it} = \mu_i + \epsilon_{it} + \beta\nu_{it}$  and it is assumed that  $\mathbb{E}(\nu\epsilon) = 0$ . Note that this formulation implies a problem similar to the classic 'error-in-variables-problem' (see e.g. Arellano, 2003). Estimates of  $\beta$  which are based on a regression of  $y_{it}$  on  $x_{it}$  will be biased upwards.<sup>17</sup> Individual heterogeneity aggravates this situation if there is positive correlation between individual fixed effects  $\mu_i$  and  $x_{it}$ . To counteract this second source of bias, a within-transformation is carried out before estimation of (3.9) by OLS.

In the following the linear models (3.7), (3.8) and (3.9), will be referred to as the naive model, the adaptive model and the rational model, respectively.

## 4 Experimental Design and Results

The present study examines behaviour in a 12-periods 4-players voluntary contribution mechanism in a strangers design. That is, for 12 periods participants were randomly assigned to groups of 4 players in order to play a linear public goods game.<sup>18</sup> In rounds 1,4,9,10 and 12 each participant was given an endowment of 3000 experimental currency units (ECU). In the remaining periods, subjects received an endowment of 2000 ECU. The marginal per capita return was 0.375 ECU in all periods. Subjects' beliefs about the average contribution of their group members was not elicited until the end of the game. After each round, subjects were informed about the average group contribution and their personal pay-off.

The game was conducted, as part of a multistage game, at the laboratory of economic psychology at the University of Vienna. In total 66 subjects participated who earned on average 13 EUR.

The discussion of the results is organised as follows: Section 4.1 gives an overview of the experimental data and documents the categorisation of participants. In section 4.2 consistency of the expectation formation assumptions with the theory of conditional cooperation is analysed at an aggregate level. Thereafter, the analysis of type-specific behaviour is discussed in section

<sup>16</sup>Selfish-biased behaviour, i.e.  $0 < \beta < 1$ , is a sufficient condition for persistence in the process  $\{\Delta y_{it}\}$ .

<sup>17</sup>Neglecting individual heterogeneity, the parameter of interest is defined by  $\beta = Cov(y, x^e)/Var(x^e)$ . Furthermore,  $Cov(y, x)/Var(x) = Cov(y, x^e - \nu)/[Var(x^e) - Var(\nu)] = \beta/(1 - \delta) > \beta$ , where  $\delta = Var(\nu)/Var(x^e)$ .

<sup>18</sup>Note that the strangers design is chosen as to exclude the possibility of strategic play.

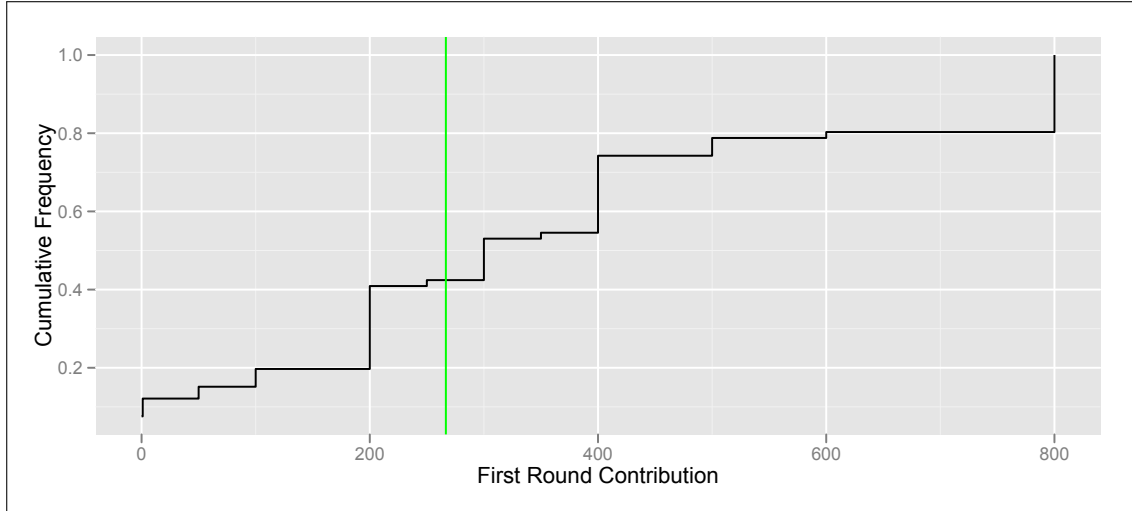


Figure 1: Cumulative frequency distribution. Blue line indicates cut-off rule of 1/3 of initial endowments

4.3.

#### 4.1 Aggregates by Type

Figure 1 shows the cumulative distribution function (cdf) of first round contributions to the public good. Out of 66 participants, 27 (40.9%) contributed less than 1/3 of their initial endowment and were thus classified as free riders. The remaining 39 participants (59.1%) were classified as conditional cooperators. At 200, 400 and 800 ECU there are stark discontinuities noticeable in the cdf. In the neighbourhood of the chosen cut-off rule, however, the distribution is fairly continuous. It was argued that the classification procedure should be robust to variations in the specific threshold level used given that initial expectations satisfy weak homogeneity assumptions and given that the theory of conditional cooperation with its extension to specific types is valid. The cdf partly supports the hypothesised robustness of categorisation with respect to variations in the cut-off rule.

Figure 2 is organised in two layers to give an overview of the experimental data. The first layer shows box-plots of contributions to the public account per period to illustrate distributive properties of the overall data. The typical pattern of repeated public good games can be nicely observed in this graphic: Contributions are initially centred around 50% of the endowment (Mean: 47.7%, Median: 37.5%) and exhibiting a clear downward trend. The Nash prediction of zero contributions is not reached until the end of the experiment. Interestingly, only 2 participants behaved like "pure" free riders and contributed zero in all periods while one participant was unconditionally cooperative by contributing her total endowment in all periods.

In a second layer, type specific behaviour is indicated in figure 2 through locally weighted regres-

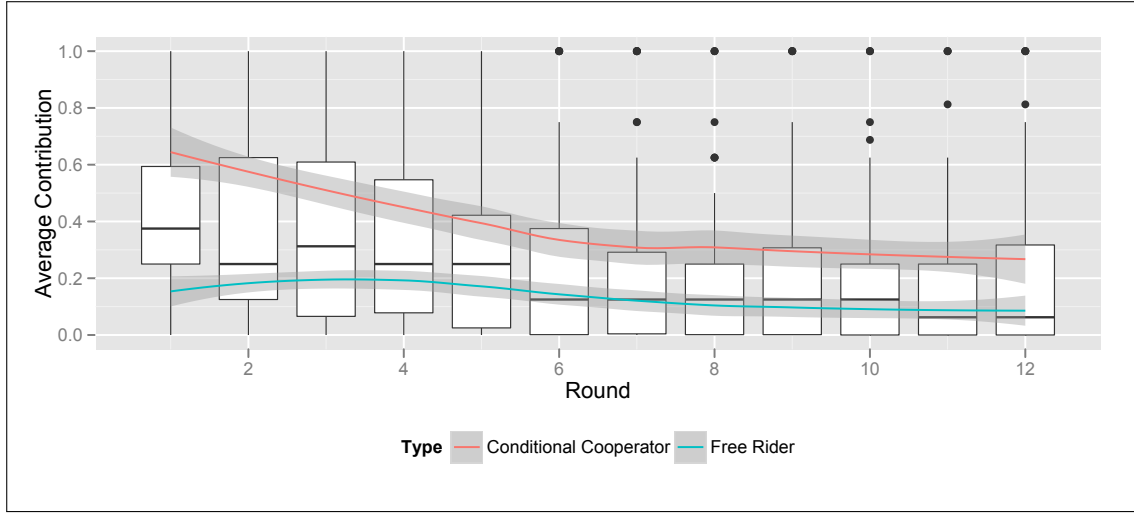


Figure 2: Overview of the experimental data: Box-plots and locally weighted regression lines by type

sions of contributions on time. The relative trend of these lines suggests that the overall decrease in contributions might be attributable to participants being classified as conditional cooperators. The average contributions of free riders and conditional cooperators are given by 14% and 39%, respectively.

To test whether the classification rule distinguishes between motivational postures and more generally, to examine the presence of a 'moral obligation' which acts as a constraint in individual maximisation, subjects were asked to indicate their opinion towards the following statement in a post-experimental questionnaire: "It is morally justified not to contribute to the public good even though others do so". Participants being classified as conditional cooperators disagreed with this statement to a significantly higher degree (Wilcoxon rank sum test, one-sided,  $p < 0.01$ ) which can be regarded as partial support for Hypothesis 4.

## 4.2 Consistency of Expectation Formation and Conditional Cooperation

Table 1 summarises estimation results of the models introduced in section 3.4.<sup>19</sup> In a first step, consistency of the theory of conditional cooperation and the introduced assumptions on expectation formation are examined at an aggregate level. Thereafter, type-specific estimates are investigated to check for plausibility of Hypothesis 4. Note that observed behaviour of the

<sup>19</sup>All calculations are executed with the statistical software R and the package "plm" (Croissant and Millo, 2008). Standard errors are based on fully general covariance structures that allow for heteroskedasticity and serial correlation of unknown form. For the naive expectations, adaptive expectations and rational expectations estimates were obtained through a random effects estimation, a gmm estimation with Arellano and Bond (1991) instruments and a fixed effects estimation (within). All models include session-specific time trends and dummy variables for income effects.

Level Model	Type Specific				
	Naive	Aggregate Adaptive	Rational	Naive	Adaptive
$x_{t-1}$	0.28***(0.05)	0.31*** (0.09)		0.18 (0.10)	0.20 (0.17)
$y_{t-1}$		0.10 (0.12)			-0.32 (0.38)
$x_t$			-0.06 (0.06)		
$x_{t-1} : CC$				0.14 (0.12)	0.12 (0.19)
$y_{t-1} : CC$					0.46 (0.36)
Sargan test		52.66 [0.17]			50.06 [0.21]
AR(1)		-2.36 [0.01]			-2.12 [0.02]
AR(2)		-1.32 [0.09]			-1.29 [0.10]
(Implied) $\beta$	0.28	0.34	-0.06	0.32	0.37

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , standard-errors are in parenthesis and p-values in brackets.

Table 1: Estimation results

aggregate is a convex combination of type specific reactions. Since conditional cooperators are supposed to positively react to others' behaviour, while free riders are supposed to not react to the behaviour of others, a negative estimate of aggregate responsiveness indicates inconsistency of the expectation formation assumption with the theory.

This reasoning suggests that both, the assumption of naive expectations and the assumption of adaptive expectations are consistent with the theory of conditional cooperation. Disregarding types, participants' contribution decision was positively correlated to their expectations under these assumptions. Under naive expectations, the estimated coefficient to other's anticipated behaviour is given by  $\beta = 0.28$ . Adaptive expectations imply an even more pronounced effect with  $\beta = 0.34$ .<sup>20</sup> Both coefficients are significantly different from zero and reaffirm previously reported evidence of a selfish-bias. Note, moreover, that the estimates are of similar magnitude. The Sargan-test of over-identifying restrictions and first and second order autocorrelations of the differenced residuals, indicated in table 1, confirm the validity of the instruments and consistency with the hypothesised error structure of the adaptive model.

The rational expectations hypothesis (Hypothesis 3), on the other hand, must be rejected. The reasoning of section 3.4 implies that the coefficient on  $x_t$  is potentially biased. Since the estimated coefficient depicts an upper bound of the true parameter, it follows that participants are, on average, either not forming expectations in a rational way or not conditioning their behaviour on the behaviour of others. The rational model is therefore excluded from the following analysis.

<sup>20</sup>The model for adaptive expectations does not provide an 'immediate' estimate of  $\beta$ . However, Slutsky's theorem in conjunction with (3.8) imply that a consistent estimate for  $\beta$  is given by  $\hat{\beta} = \gamma_1 / (1 - \gamma_2)$  where  $\gamma_1$  and  $\gamma_2$  are the estimated parameters in the regression  $y_t = \alpha + \gamma_1 x_{t-1} + \gamma_2 y_{t-1} + \epsilon_t$

### 4.3 Type-Specific Analysis

Type specific estimates are reported in the last column of table 1.<sup>21</sup> Both models investigated are consistent with the hypothesis that initial choice signals cooperative disposition. Under naive expectations, the estimated response of free riders (the baseline group) to expected behaviour of others is not significantly different from zero. A linear hypothesis test shows that the same Null-hypothesis must be rejected for participants being classified as conditional cooperators (p-value < 0.001).

To interpret the coefficients of the adaptive model, note that Hypothesis 4 implies that free riders' contribution decision is not correlated to  $x_t^e$  and thus, not correlated to  $(x_{t-1}, y_{t-1})$  under the assumption of adaptive expectations. The estimation results in table 1 are consistent with this prediction since both coefficients are not significantly different from zero in the baseline group. Conditional cooperators, on the other hand, are driven by expectations. Under validity of the adaptive expectations hypothesis, the estimation results imply that conditional cooperators' response to  $x_t^e$  is given by  $\beta = 0.37$ .<sup>22</sup>

Estimates of  $\beta$  are summarised in the last row of Table 1 where the column labeled "Type specific" contains estimates for conditional cooperators. Note that coefficients obtained under the assumption of adaptive and naive expectations are of similar magnitude. This can be ascribed to the following observation. The free parameter of the adaptive expectations algorithm (3.4) was estimated to be  $\lambda = 0.90$  in the aggregate model and  $\lambda = 0.86$  in the type-specific model. While a value of zero implies that expectations are autonomous of the observed data, a value of 1 corresponds to naive expectations. Thus, applied to our dataset, both modelling approaches acknowledge the importance of recently observed data.

Interestingly, the response *between* types cannot be safely distinguished in either model; that is, interactions are not significant. Although the coefficients on the interaction terms are, as theory predicts, positive, considerable variation inhibits a precise discrimination. In order to further explore this issue, the following section takes a closer look on the quality of categorisation. The analysis will be based on a variable coefficient model, i.e.  $\beta$  will be treated as a random variable rather than a parameter. Since naive and adaptive expectations are fairly consistent, in the above mentioned sense, but estimation results based on the simpler structure of the naive model are more robust, the following analysis concentrates on naive expectations alone.

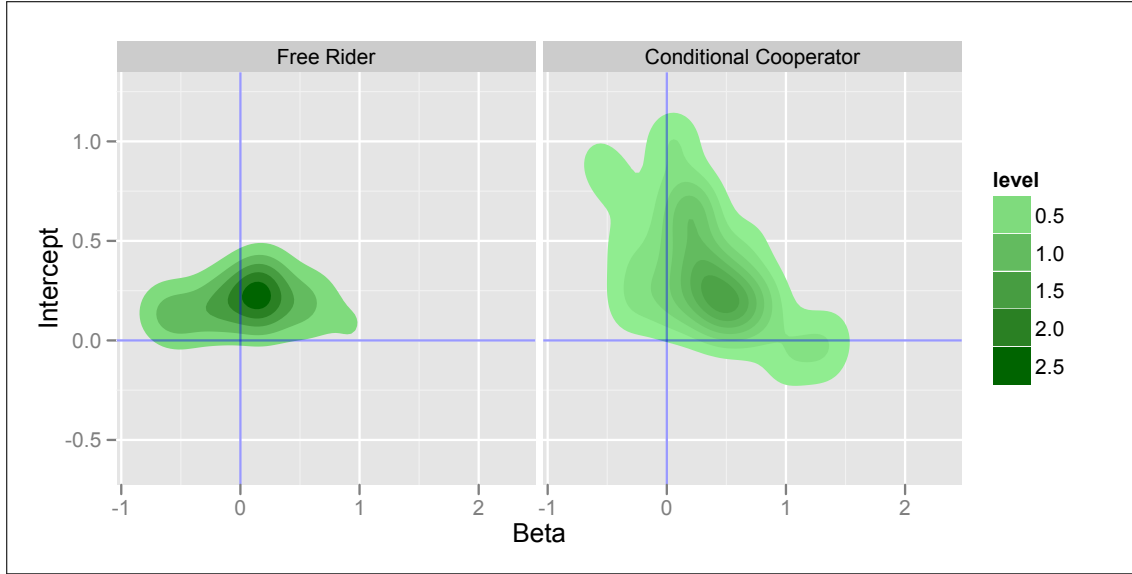


Figure 3: 2D density plots by type. Dark colours indicate high density.

#### 4.4 Quality of Categorisation

To get a more detailed picture of the quality of categorisation, the naive model is separately estimated for each individual.<sup>23</sup> The hereby obtained intercepts and coefficients are employed in constructing two-dimensional density estimates per type which are presented in Figure 3. The response to others' (lagged) behaviour is indicated on the x-axes and the y-axes maps the estimated intercepts. Recall that 'perfect' free riders contribute zero irrespective of the contribution of others. Consequently, this stereotype is located at  $(0, 0)$  in the two-dimensional intercept-slope space. 'Perfect' conditional cooperators, on the other hand, mirror the behaviour of others which implies the location  $(1, 0)$ .

Figure 3 conveys three unambiguous messages. First, categorisation based on initial contributions reveals some kind of cooperative disposition. Otherwise, the density plots were not different. Second, free riders exhibited less heterogeneity in their behaviour than conditional cooperators, i.e. the distribution of free riders is more dense. Third, the centres of distribution do conform, to some degree, to the theoretical prediction. The mean of free riders is located at  $(0.08, 0.37)$ . The mean of conditional cooperators is located at  $(0.19, 0.35)$ .

The graph also provides a clear intuition for the insufficiency of reciprocity, alone, to discriminate between types. While type specific expected values of the coefficient are ordered in accordance

<sup>21</sup>CC denotes a dummy variable for types. Free riders are the baseline group.

<sup>22</sup>A linear hypothesis test shows that  $x_{t-1} + x_{t-1} : CC = 0$  must be rejected (p-value < 0.001). Since this term is an estimate of  $\lambda\beta$  and  $\lambda < 1$ , it follows that also  $\beta$  must be significantly different from zero.

<sup>23</sup>A dummy variable regression was employed with aggregate time effects. Robust covariance estimation with common variance inside every group.



with the theory, there is considerable overlap in the underlying distributions between types. In particular, a large fraction of conditional cooperators showed little responsiveness to others' lagged behaviour. By taking the second dimension of Figure 3 into account, the impossibility to neatly separate conditional cooperators from free riders on grounds of initial contributions becomes more clear. A non-negligible fraction of participants exhibited some kind of 'unconditionally cooperative' behaviour, which is implied by being located near  $(0, 1)$ .

Thus, the insufficiency of a contribution based categorisation rule to distinguish between types might be grounded in an insufficient specification of types. To further clarify this issue, the following definition is introduced. A participant is called unresponsive if the estimated coefficient on lagged contributions of others is not significantly different from zero. If the (one-sided) hypothesis of unresponsiveness must be rejected, the participant is called responsive. This definition enables a quantitative assessment of the quality of categorisation *within* each group.

Table 2 summarises in a contingency-table the relation between types and responsiveness. Out of 27 participants that were classified as free riders, 24 (88.9%) are, in accordance with the theory, unresponsive. However, only 12 out of 39 participants (30.8%) that were classified as conditional cooperators are responsive. To put this observation into perspective note that in total 51 participants exhibited unresponsive behaviour while only 15 participants exhibited responsive behaviour. Thus, another way to interpret these figures is to say that 24 out of 51 unresponsive participants (47%) were correctly classified as free riders while 12 out of 15 participants (80%) were correctly classified as conditional cooperators.<sup>24</sup>

	Responsive	Unresponsive
Free rider	3	24
Conditional cooperator	12	27

Table 2: Contingency-table: Type and Responsiveness

Clearly, this table reaffirms the intuition gained from Figure 3. Although initial contributions unambiguously signal some kind of cooperative disposition, the categorisation on basis of the above described types is less than perfect, i.e. neither exclusive nor exhaustive.

## 5 Summary and Concluding Remarks

This paper presented data from a public goods experiment, conducted in a random matching design, where subjective beliefs on the average behaviour of others were not elicited. Instead,

<sup>24</sup>The number of responsive participants is heavily dependent on the specific estimation technique employed. However, the stated fractions largely remain constant. Without robust covariance matrix estimation only 6 participants show responsive behaviour. A covariance matrix allowing for heteroskedasticity between and within groups yields 16 responsive participants.

three widely used definitions of expectation formation were employed in order to investigate the theory of conditional cooperation in general and the existence of types in particular.

On basis of first round contributions participants were classified as free riders or as conditional cooperators. This indicator variable was then employed in order to construct estimates of "responsiveness", i.e. the degree of reciprocating anticipated behaviour of others. The estimation approach relied on three widely used expectation formation algorithms: rational expectations, adaptive expectations, and naive expectations. In a first step, where consistency of these expectation formation assumptions with the theory of conditional cooperation was tested, the assumption of rational expectations had to be excluded from the analysis. Evidently, participants were either not basing their decisions on the behaviour of others or they were not forming expectations rationally in the sense of Muth (1961).

However, the results show that both, adaptive and naive expectations are consistent with reciprocal behaviour of the aggregate and importantly, also with the hypothesis that first round contributions signal some form of cooperative disposition. In accordance with the theory, individuals that were classified as conditional cooperators displayed a higher degree of responsiveness than free riders. This ordering holds true for both expectation formation algorithms. While that finding is remarkable, the study also pointed out deficiencies of the categorisation approach. Between types, the experimental data did not indicate significant differences, i.e. within the group of free riders, a considerable fraction of individuals behaved conditionally cooperative and vice versa. This might be traced back to an insufficient specification of types. A detailed analysis of individual heterogeneity reveals that conditionally cooperative behaviour alone may fall short of explaining observed behaviour of non-free riders. A non-negligible fraction of participants exhibited some form of unconditionally cooperative behaviour.

An ongoing debate in the social sciences concerns the appropriate choice of policies to improve cooperation. One such policy which has been shown to deter uncooperative behaviour of free riders in public good settings is the availability of sanctions (see e.g. Nikiforakis, 2004, 2010). However, the enforcement of cooperation is in general associated with costs. One may therefore argue that 'belief-management', as proposed by Thöni, Tyran, and Wengström (2009), entails a more efficient measure to motivate conditionally cooperative agents. Tailored policies may increase efficiency given that cooperative disposition depicts a personality trait, rather than a state, and given that types are distinguishable.

This paper contributes to the existing literature by presenting one simple rule how to distinguish types and by providing further evidence for the importance of reciprocity. Notably, this evidence is gained whilst abstaining from an explicit elicitation of beliefs which might bias behaviour by making others' choice more salient. If policy makers succeed in grouping conditionally cooperative individuals, efficiency in the provision of public goods might be enhanced without incurring additional costs of intervention.

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## 6 Appendix

### 6.1 Summary

#### English

Experimental evidence is at odds with the Nash prediction of free riding in public good games. Participants don't seem to be driven by pecuniary maximisation alone, but by some form of other-regarding preferences as well. One recent and broadly accepted explanation of non-zero contributions is offered by the theory of conditional cooperation. It posits that most people are willing to cooperate given that others do so as well. Moreover, there appears to exist, at least, a second type of player. Some individuals, commonly referred to as free riders, pursue the maximising strategy of zero contributions in all rounds. The interaction of these types reasonably well explains observed behaviour in public good experiments.

The present study investigates the theory of conditional cooperation in general and the existence of types in particular. It is hypothesised that first round contributions signal cooperative dispositions. Accordingly, separate estimates for individuals contributing below or above a certain threshold level of first round contributions are obtained. The variable of interest is the reaction to other's expected behaviour. Individuals categorised as conditional cooperators ought to reciprocate these expectations while free riders are expected to not react to them. Since subjective expectations were not directly elicited in order to avoid anchoring effects, three widely used expectation formation algorithms were employed instead.

The results of the experiment indicate that first round contributions, indeed, signal some form of cooperative disposition. However, the categorisation procedure used appears not to be exclusive or exhaustive. Apparently, there exists another type of player in public good games who acts unconditionally cooperative. Another result of the study is that both, adaptive and naive expectations are consistent with the theory of conditional cooperation while the hypothesis rational expectations is not consistent.

## Deutsch

Experimentelle Ergebnisse stehen im Widerspruch zu der Vorhersage des Nash-Gleichgewichts von Null-Beiträgen bei Public Good Games. Individuen scheinen nicht durch finanzielle Anreize allein, sondern auch durch das Verhalten anderer Mitspieler beeinflusst zu sein. Eine aktuelle und breit akzeptierte Erklärung der Nicht-Null-Beiträge wird durch die Theorie der bedingten Kooperation angeboten, welche besagt, dass die meisten Menschen bereit sind zu kooperieren, gegeben, dass die anderen Teilnehmer auch kooperieren. Des Weiteren scheint zumindest eine zweite Art von Spieler zu existieren. Einige Personen, die gemeinhin als Trittbrettfahrer bezeichnet werden, verfolgen die Maximierungs-Strategie der Null-Beiträge in allen Runden. Das Zusammenspiel dieser Typen kann das beobachtete Verhalten in Öffentlichen Gut Experimenten gut erklären.

Die vorliegende Studie untersucht die Theorie der bedingten Kooperation im Allgemeinen und die Existenz von Typen im Speziellen. Es wird angenommen, dass Beiträge zum öffentlichen Gut in der ersten Runde die kooperative Disposition der Teilnehmer signalisieren. Dementsprechend werden separate Schätzungen für jene Personengruppen durchgeführt deren Beiträge über oder unterhalb eines gewissen Schwellenwertes in der ersten Runde liegen. Die interessierende Variable dieser beiden Gruppen ist die Reaktion auf das erwartete Verhalten der anderen Teilnehmer. Personen, die als bedingt kooperierende Individuen eingestuft werden, sollten diese Erwartungen in ihren eigenen Handlungen spiegeln, während von Trittbrettfahrer zu erwarten ist, dass deren Verhalten unabhängig von deren Erwartungen ist. Da subjektive Erwartungen nicht direkt erhoben wurden um Verankerungseffekte zu vermeiden, wurden drei weit verbreitete Erwartungsformationsalgorithmen eingesetzt.

Die Ergebnisse des Experiments zeigen, dass Beiträge in der ersten Runde tatsächlich eine Form von kooperativer Disposition signalisieren. Allerdings scheint das eingesetzte Kategorisierungsverfahren nicht vollständig und ausschließlich zu sein. Offenbar existiert eine weitere Art von Spieler in Public Good Games, deren Verhalten durch bedingungslose Kooperation gekennzeichnet ist. Darüber hinaus zeigen die Ergebnisse, dass sowohl adaptive als auch naive Erwartungen im Einklang mit der Theorie der bedingten Kooperation stehen während sich rationale Erwartungen als inkonsistent mit der selbigen erweisen.



## 6.2 Curriculum Vitae

### Contact Information

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### Education

Since 2012	Phd in International Business Taxation, University of Business and Economics, Vienna
2010 - 2012	MSc in Economics, graduation with honours, University of Vienna and Universidad Carlos III, Madrid
2007 - 2009	BSc in Economics, University of Vienna
2005 - 2013	Diploma (equivalent to BSc + MSc) in Economic Psychology, University of Vienna

### Employment

Summer 2011	Internship; Economic & Market Analysis Bank Austria
2010 - 2011	Research Assistant, Department of Economic Psychology, University of Vienna
Spring 2010	Internship; Department of Economic Psychology, University of Vienna

### Other Information

2012	Franz-Weninger Award from the Austrian National Bank for Master Thesis „Learning and Restricted Perceptions in the New Keynesian Model“
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