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Douadia Bougherara, Sandrine Costa, Gilles Grolleau, Lisette Ibanez

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Positional Concerns in Public Goods Games¹

D. Bougherara, S. Costa, G. Grolleau, L. Ibanez

Preliminary version, do not quote

1. Introduction

From the prisoners' dilemma outcome, individuals should never contribute to finished public good games. Indeed, economic experiments show that individuals express voluntary participation in public good games. Since a lot of theoretical or experimental works explain this participation by different motivations, as warm-glow (Andreoni, 1990), reciprocity (Falk and Fishbacher, 2006), reciproque altruism (Axelrod and Hamilton, 1981), pure altruism (Nyborg, 2000), social norms (Nyborg, Rege, 2003; Rege and Telle, 2004; Andreoni and Petrie, 2004).

We study here how positional concerns may also explain voluntary participation to public goods. There exists empirical evidence that people care about their relative position in society, and that the search for status implies that the relative performance rather than the absolute performance determines the individual utility (Frank, 1985; Congleton, 1989, Solnick and Hemenway, 1998). In a recent survey, Solnick and Hemenway (2005) show that some public goods are as positional than private ones (for instance, national defense or space exploration spending). Positional concerns have then to be considered when the question of public good funding is studied.

Considering positional preferences leads to the question of strategic manipulations of Public Goods Games. *If individuals care about their status, defined as their rank in the distribution of consumption of one "positional" good, then the consumer's problem is strategic as her utility depends on the consumption choices of others* (Hopkins and Kornienko, 2004). Strategic manipulations of Public Goods Games have already been studied in game theory and in experimental works (Kreps, 1982; Andreoni, 1988; rajouter des références). However, these papers do not integrate positional concerns in their analyse.

The scope of this paper is to analyse how positional preferences modify voluntary participation to Public Goods, and to study how positional preferences modify strategic manipulations of Public Goods Games. This paper is organised as follows. First, we propose a theoretical model of consumer behaviour with positional preferences. Second, we analyse the assumptions of the theoretical model with experimental data of Andreoni (1988). Finally, we conclude and discuss future research.

¹ Nous tenons à remercier Jean-Marc Rousselle pour son soutien dans le déroulement de l'expérimentation et dans l'exploitation des données.

[remarque : il faut peut-être réfléchir un peu plus à l'argumentation de l'intro : solnick et hemenway mtq les gens préfèrent être dans un pays qui dépense plus que les autres en défense ou exploration de l'espace; pas tout à fait la même chose que ce qu'on fait : ie on dit que les gens aiment payer plus que les autres pour un bien public, ça peut donc être au niveau d'un même pays]

2. A model of consumer behaviour with positional preferences

a) One-period model

In our model, we suppose consumers to adopt positional behavior. We will write the utility function for individual i as follows :

$$U_i(x_i, x_j) = \pi_i + \alpha_i \times \left(x_i - \frac{x_j}{N-1} \right) \quad (1)$$

Where the first term is the *monetary payoff* of individual i , and the second term is the *positional utility*. The monetary payoff π_i is induced by the experimenter, and is defined as :

$$\pi_i = D - px_i + \frac{G}{N}(x_i + x_j) \quad (2)$$

Where D represents the monetary endowment, x_i is the amount of money individual i contributes to the public project at the date t , and p the cost of this contribution. G is the group marginal payoff, N is the number of individuals, $\frac{G}{N}$ is the marginal per capita return of public project, and x_j is the total amount of other players' contributions.

The reciprocity utility is composed of two terms :

- The constant α_i , which we call *positional behaviour*. This constant depends on the *strength* of positional behaviour. For instance, if someone does not care about reciprocity, $\alpha = 0$. In that case, as stressed by Falk and Fischbacher (2006), "the player has *Homo economicus* preferences". This constant depends also on the *nature* of positional behaviour. We consider two types of behaviour, the *positional egoism* ($\alpha_i < 0$) and the *positional altruism* ($\alpha_i > 0$).
- The second term is the difference between individual i 's contribution and the average contribution of all other players $\left(x_i - \frac{x_j}{N-1} \right)$.

The model we consider here describes positional goals and therefore consider relative contribution to influence utility levels. $\left(x_i - \frac{x_j}{N-1} \right) > 0$ means that individual i contributes more than others, in average. Then, if $\alpha_i > 0$, individual i 's utility is increased when he contributes more than others to public good. This behaviour is different from the warm-glow behaviour (Andreoni, 1990) because in

the warm-glow behaviour individuals do not care about contributions of other players. More precisely, in our model, if someone contributes to public good at the same amount than all others (in average), her contribution will not give her other benefit than the monetary one. In the case of *positional altruism* (with $\alpha_i > 0$), individual i contributes relatively more than others, the positional utility will be positive which signifies that the individual i enjoys the distinction from other players and thus gains a non monetary pay-off.

If yet $\alpha_i < 0$, individual i 's utility is increased when he contributes relatively less than others to public good. In the case of *positional egoism* ($\alpha_i < 0$) an individual enjoys benefiting from the public good without having paid for it. It is the pleasure "to make a good deal", and moreover "to make a better deal than other players".

So, whatever the sign of α , the scope of the individual is to distinguish their behavior from others.

Proposition 1 : Positional altruists contribute to the public good, if the non monetary value of status (α_i) is higher than the monetary loss of contributing to the public good ($p - \frac{G}{N}$).

Proof :

The optimal contribution is such that : $Max_{x_i} U_i(x_i, x_j)$

From which, it can be deduced that : $\frac{\partial U_i(x_i, x_j)}{\partial x_i} = -p + \frac{G}{N} + \alpha_i > 0 \Leftrightarrow \alpha_i > p - \frac{G}{N}$

The optimal contribution to the public good is such that $x_i^* = 0$ if $p - \frac{G}{N} > \alpha_i$ and $x_i^* = D$ if $p - \frac{G}{N} < \alpha_i$

So, status seeking may counter-balance free-riding incentives, and when positional concerns are considered more consumers should contribute to public goods.

b) multi-period model

We define the utility of individual i , at date t , as :

$$U_{i,t}(x_{i,t}, x_{j,t}) = \pi_{i,t} + \alpha_i \times \left(x_{i,t} - \frac{x_{j,t}}{N-1} \right)$$

Where the first term is the *monetary payoff* of individual i at date t , and the second term is the *positional utility*. The monetary payoff $\pi_{i,t}$ is defined as before :

$$\pi_{i,t} = D - px_{i,t} + \frac{G}{N}(x_{i,t} + x_{j,t})$$

From () and (), it comes easily :

$$U_{i,t}(x_{i,t}, x_{j,t}) = D - px_{i,t} + \left(\frac{G}{N} + \alpha_i\right)x_{i,t} + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right)x_{j,t}$$

So, contributing to the public good represents a private monetary cost (p), which may be counter-balanced by a monetary benefit ($\frac{G}{N}$) and a positional one (α_i). As shown previously, positional altruists (such that $\alpha_i > 0$) enjoy to give more than others, and have non monetary benefit when they contribute to the public good. When others contribute to the public good, they increase the monetary benefit of individual i ($\frac{G}{N}$) and they contribute to the positional utility ($-\frac{\alpha_i}{N-1}$). If individual i is a positional altruist and likes to give more than others, then when others contribute to public good, it decreases her non monetary benefit ($-\frac{\alpha_i}{N-1} < 0$). If individual i is a positional egoist ($\alpha_i < 0$) and likes to give less than others, her non monetary positional benefit is increased when others contribute to the public good ($-\frac{\alpha_i}{N-1} > 0$).

When a consumer chooses how much she contributes to the public good, she doesn't know what will be the choice of other consumers. We assume here that each consumer has subjective probabilities on others choices $x_{j,t}$ and that these subjective probabilities depend on her own contribution at previous date $x_{i,t-1}$: a consumer anticipates that her choice at date $(t-1)$ influences others' choice at date t . Moreover, we assume that the subjective probability that other players contribute $x_{j,t}$ at the date t depends on her contribution at previous dates ($x_{i,t-2}, x_{i,t-3}, x_{i,t-4}, \dots$). Indeed, players have some subjective ideas about how other players respond to their own contribution and these subjective probabilities may get modified after each period, when they observe the real response of others. So consumers get more informed after each period.

Consumers make a sequential choice : they choose how much they contribute to the public good at the beginning of each period. At date t , each consumer maximises her expected utility function over the next periods. Optimal contributions of consumers are determined by backward induction. As usual, we determine firstly the optimal contribution at the last period.

Proposition 2 : Positional altruists contribute to the public good at the last period, if the non monetary value of status (α_i) is higher than the monetary loss of contributing to the public good

$$\left(p - \frac{G}{N}\right).$$

Proof :

The optimal contribution at the date T is such that : $\underset{x_{i,T}}{\text{Max}} E_{i,T} U_{i,T}(x_{i,T}, x_{j,T})$

From which, it can be deduced that : $\frac{\partial E_{i,T} U_{i,T}(x_{i,T}, x_{j,T})}{\partial x_{i,T}} = -p + \frac{G}{N} + \alpha_i > 0 \Leftrightarrow \frac{G}{N} > p - \alpha_i$

End of proof.

As usual, the solution of the last period is similar to the one-period public good game. We now consider the period T-1.

Proposition 3 : Optimal contribution to the public good at the before last period T-1 depends

- **on positional behavior (α_i) and**

- **on Expected Strategic Return of Investment (ESRI) $\frac{\partial E_{i,T-1}(E_{i,T} x_{j,T})}{\partial x_{i,T-1}}$**

and is such that :

$$x_{i,T-1}^* = 0 \text{ if } \forall x_{i,T-1} \in [0, \frac{D}{p}], \left(-p + \frac{G}{N} + \alpha_i \right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1} \right) ESRI(x_{i,T-1}) < 0$$

$$x_{i,T-1}^* = \frac{D}{p} \text{ if } \forall x_{i,T-1} \in [0, \frac{D}{p}], \left(-p + \frac{G}{N} + \alpha_i \right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1} \right) ESRI(x_{i,T-1}) > 0$$

$$\text{else, } 0 < x_{i,T-1}^* < \frac{D}{p} \text{ and such that } \left(-p + \frac{G}{N} + \alpha_i \right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1} \right) ESRI(x_{i,T-1}^*) = 0$$

Proof.

At date T-1, the optimal choice of the consumer is such that :

$$\text{Max}_{x_{i,T-1}} E_{i,T-1} \left(U_{i,T-1}(x_{i,T-1}, x_{j,T-1}) + E_{i,T} U_{i,T}(x_{i,T}^*, x_{j,T}) \right)$$

which can be expressed as :

$$\text{Max}_{x_{i,T-1}} \left(2D + \left(-p + \frac{G}{N} + \alpha_i \right) (x_{i,T-1} + x_{i,T}^*) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1} \right) (E_{i,T-1}(x_{j,T-1} + E_{i,T} x_{j,T})) \right)$$

In this equation $E_{i,T-1}(E_{i,T} x_{j,T})$ depends on $x_{i,T-1}$, since we assumed that subjective probabilities that other players contribute $x_{i,T-1}$ depend on player's i contribution at the previous date $x_{i,T-1}$. We also assumed that the contribution of other players at date t does not depend of player's i contribution at the same date, car jeux simultanés. Derivation of previous equation gives then optimal contribution at date T-1.

End of Proof.

We call « Expected Strategic Return of Investment (ESRI) », here equal to $\frac{\partial E_{i,T-1}(E_{i,T} x_{j,T})}{\partial x_{i,T-1}}$, the

expected effect of player's i contribution at one date on other players' contribution at future dates. Player i takes into account this expected effect, since her utility depends on others' contribution

through monetary and non monetary motives. To interpret easily previous proposition, let us consider that ESRI is constant, whatever the player and her contribution. Player i should contribute if

$$\left(-p + \frac{G}{N} + \alpha_i\right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right)ESRI \geq 0. \text{ Do positional concerns increase or decrease the voluntary}$$

participation to public goods, when we take into account strategic manipulations ? A player without

any positional concerns (such that $\alpha_i = 0$) should contribute if $\left(-p + \frac{G}{N}\right) + \frac{G}{N}ESRI \geq 0$. Positional

concerns increase participation to public goods if :

$$\left(-p + \frac{G}{N} + \alpha_i\right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right)ESRI > \left(-p + \frac{G}{N}\right) + \frac{G}{N}ESRI$$

It is easy to show that this condition is true, for positional altruists (such that $\alpha_i > 0$) iff $\frac{ESRI}{N-1} < 1$, and

for positional egoists (such that $\alpha_i < 0$) iff $\frac{ESRI}{N-1} > 1$. $\frac{ESRI}{N-1}$ represents the average contribution of

others in the last period for 1 token more contribution of player i in the before last period. Positional altruists contribute more than people who do not care about position if they think that others will not increase their contribution too much in the next period. A contrario, positional egoists contribute more than people who do not care about position if they think that their contribution will have a strong effect on others contribution on the next period.

At other dates than T-1, quite the same proposition holds (see Appendix 1). The only difference comes from the ESRI term, which takes into account all the future periods until the end of the game. However previous interpretation allways holds.

So in a multi period game, the effect of positional concerns on participation to public goods is less clear than in a one-period game, as choices depend also on expectations about how others will react to my own contribution.

We test our theoretical assumptions on the famous partners/strangers experiment of Andreoni (1998)². The comparison of partners and strangers results will be useful to test for the strategic part of our model and for positional concerns.

As stressed by Andreoni (1988), one player may try to influence future actions of other players in a Partners' game, whereas strategic manipulations are not possible in Strangers' game. Andreoni tests

² Andreoni (1988) studied experimentally the impact of learning and strategic action on contributions in a public good game. He argues that individuals may need time and experience to recognize his dominant strategy (*learning hypothesis*). He also argues that individuals may voluntarily contribute to the public good (and thus deviate from his dominant strategy) in order to influence their partners' actions (*strategies hypothesis*). He proposes an experiment that allows to test separately these two hypothesis. However « *both the strategies and learning hypotheses are contradicted in the experiment* ».

for the strategic behaviour described by Kreps et al (1982) in an incomplete information game. Players contribute to the public good early in the game, in order to conceal that they behave rationally. In that framework, contribution to public good should be higher in Partners'treatment than in Strangers'treatment. Strategies hypothesis is contradicted by Andreoni's experiment because contribution to public good is higher in Strangers'game than in Partners'game. In our theoretical framework, contribution to public good could be smaller in Partners case than in the Strangers one. Consider for instance positional altruists (such that $\alpha_i > 0$). It is possible for them to contribute more to the Strangers'game than to the Partners'game. If $-p + \frac{G}{N} + \alpha_i > 0$ they give all their donation to the public good in Strangers'game, and if $\forall x_{i,t} \in \left[0, \frac{D}{p}\right] \left(-p + \frac{G}{N} + \alpha_i\right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right) ESRI(x_{i,t}) < 0$, they do not contribute to the Partners'treatment. These 2 conditions might be simultaneously true if the second part of the previous equation is negative. This is the case if these persons expect that an increase in their own contribution decreases others' contribution (ie $ESRI(x_{i,t}) < 0$) and they are not too much positional altruists ($\frac{G}{N} - \frac{\alpha_i}{N-1} > 0$): in that case, they contribute less to the Strangers'game than to the Partners'game, because decreasing their own contribution will increase others contribution in the next periods, and the monetary benefit of others'contribution ($\frac{G}{N}$) will be higher than the non monetary loss ($\frac{\alpha_i}{N-1}$). This is also the case if these persons expect that an increase in their own contribution increases others' contribution (ie $ESRI(x_{i,t}) > 0$) and they are very positional altruists ($\frac{G}{N} - \frac{\alpha_i}{N-1} < 0$): in that case, they contribute less to the Partners'game than to the Strangers'game, because by decreasing their own contribution they incite others to contribute less in the next periods, and the positional benefit ($\frac{\alpha_i}{N-1}$) will be higher than the monetary loss ($\frac{G}{N}$). So interaction of monetary and non monetary motives makes the strategic effect more unclear.

In our theoretical model, a positional player (ie such that $\alpha_i \neq 0$) gets more happy when her contribution gets more different from other's contribution. We test the positional assumption on results of the Strangers'experiment, because in this experiment there are no strategic motives, as explained before, but there are also no punishment/rewarding behaviours (reciprocity, as in Falk and Fischbacher, 2006) and no tit-and-tat strategies (reciproque altruism, as in Axelrod and Hamilton, 1981). By comparison of Partners'experiment and Strangers'experiment, we test if some positional effects remain valid.

3. Experimental analysis

In Andreoni's experiment, Partners played during all 10 periods with the same four partners, whereas Strangers were assigned into a new group of 5 at every period³. The analytic gain function reinitialized at each period for both Strangers and Partners used during the experience was the following :

$$G_i = 50 - x_i + 0.5 \sum_{i=1}^5 x_i .$$

The scope of econometric analysis is to explain individual contribution to the public good by strategic and positional variables. The general model we use is specified as follows :

$$contrib_{it} = Cons + \sum_j \beta_j X_{it,j} + \alpha_i + \varepsilon_{i,t}$$

where :

- *Cons* is the intercept
- $X_{it,j}$ are the regressors not including the constant term. We consider here four variables : Position, which describes position of player *i* in terms of relative contribution ; ESRI, which is a proxy for individual *i*'s beliefs on other players' future contributions ; Partners, a dummy equal to one for Partners' games ; and Period.
- α_i are the individual effects,
- $\varepsilon_{i,t}$ is the error term.

Position at period *t* is defined as the difference, at date *t-1*, between Player's *i* contribution and the average contribution of other individuals. Positional regressor is calculated at period *t-1* and not period *t* because when Player *i* has to choose her contribution amount for Period *t* she has no information on others contribution for Period *t*, whereas she knows how much other Players contribute in the previous Period. Position variable being defined for periods 2 to 10, econometric analysis will be conducted for these 9 periods.

As expectations by individual *i* on others' future behavior with respect to individual *i*'s contribution are unobservable, we create a proxy that approximates these expectations. Moreover, we consider player *i* updates his beliefs on strategic return of investment at each period as new information on the contribution level of other players in reaction to his previous contribution decisions becomes available,

³ Andreoni made an unexpected « restart » after the tenth period of the game, to test for the learning hypothesis. This restart was not announced to the participants to the experiment , and did not influence their contributions in the ten first periods. So, we consider here only the first ten periods.

as in Cason and Gangadharan (). The proxy variable, Expected Strategic Return of Investment (ESRI) is calculated as follows ⁴:

$$ESRI_{i,4} = \frac{Contrib_{-i,3} - Contrib_{-i,2}}{Contrib_{i,2} - Contrib_{i,1}}$$

$$ESRI_{i,t} = \frac{\frac{Contrib_{-i,t-1} - Contrib_{-i,t-2}}{Contrib_{i,t-2} - Contrib_{i,t-3}} + (t-3)ESRI_{i,t-1}}{t-2} \text{ for } t > 4.$$

$$ESRI_{i,3} = ESRI_{i,2} = 0$$

Where $Contrib_{-i,t}$ refers to the total contribution of other individuals (of the same group) at date t.

So, if the variable is positive, the individual believes that other players react positively (in terms of future contribution) to an increase of his actual contribution. And inversely, if the variable is negative, the individual believes that an increase of his contribution level will reduce the future participation of other players. In our analysis only Partners should have strategic incentives as they play always with the same players, whereas Strangers never play together with the same players. Therefore, we would expect the ESRI variable to explain the contribution level only for the Partner treatment.

Next table presents all the variables we use in econometric analysis.

Table1 : Meanings and statistics of variables used in the econometric analyses, periods 2 to 10

Variable	Description	Statistics : Mean (s.d.)		
		All experiments	Partners games	Strangers games
$Contrib_{it}$	Individual i's contribution to the public good, tokens	18.31 (16.12)	15.77 (16.06)	20.21 (15.91)
$Position_{it}$	Difference between the contribution of individual i and the average contribution of other individuals at period t-1, tokens	0 (17.57)	0 (17.07)	0 (17.95)
$ESRI_{it}$	Expected Strategic Return of Investment for one contribution unit	-0,27 (2.7)	0.40 (2.34)	-0.77 (2.84)
Partners	Dummy = 1 for Partners treatment, 0 otherwise			
Obs., Nb		630	270	360

Partners contribute less than Strangers in average. This result might be characteristic to the experiment. Indeed Croson (1996) found in a similar experiment a contrary result, i.e. that Partners contribute more than Strangers.

Two approaches may be used to fit this model : the fixed effects regression, where α_i is assumed to be constant ; and random effects regression, where α_i are treated as random variables and are assumed to be uncorrelated with the regressors. We performed these two estimation methods and tested for fixed or random effects with the Hausman's test (see for instance Greene, 2000, chapter 14). The hypothesis that the individual effects are uncorrelated with the other regressors is rejected, Hausman's test value

⁴ In the case the contribution level for i is identical in t-2 and t-3, we set $ESRI_{i,t} = 0$ if t=4, or $ESRI_{i,t} = ESRI_{i,t-1}$ if t>4.

being far larger than the critical value (Appendix 2 gives detailed results of the random effects model). So, fixed effects estimation is chosen.

More precisely, we estimate a Least Square Dymmy Variables (LSDV) model :

$$Contrib_{it} = Cons + \beta_1 Position_{it} + \beta_2 ESRI_{it} + \beta_3 Partners + \beta_4 Period + \alpha_i d_i + \varepsilon_{it}$$

Where d_i is a dummy variable indicating i^{th} Player. We also test for slope dummy variables: $Partners \times Position_{it}$ and $Partners \times ESRI_{it}$.

Our model includes the intercept (*Cons*), all dummies for Players, and the dummy Partners. We introduce two restrictions⁵ to avoid the perfect multicollinearity, or the « dummy variable trap ». First

restriction is that $\sum_{i=1}^{70} \alpha_i = 0$. Coefficient α_i then measures the difference to the mean value of all

Players. Second restriction is that $\sum_{i \in Partners} \alpha_i = 15.7 - 18.3$ and makes sure that the sum of the coefficients

of Partners' dummies equals the mean difference between Partners and all Players.

All regressions are estimated with PROC REG (SAS), which allows to introduce restrictions on dummy variables (see for instance Myoung Park, 2008). The significance of fixed effects is tested with a F test that parameters of Players dummies are zero (as in Greene, 2000). Next table provides the results of the regression and of the test of fixed effects.

⁵ When the model is estimated without the dummy Partners, we then keep only one restriction (the first one).

Table 2 : Fixed effects model of individual contribution

	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5
<i>Intercept</i>	28.77*** (1.11)	30.86*** (1.19)	28.77*** (1.11)	30.88*** (1.17)	30.90*** (1.19)
<i>Period</i>	-1.74*** (0.17)	-1.74*** (0.17)	-1.74*** (0.17)	-1.74*** (0.17)	-1.74*** (0.17)
<i>Partners</i>		-4.92*** (0.95)		-4.92*** (0.91)	-4.98*** (0.95)
<i>ESRI_{it}</i>	0.03 (0.24)	-0.001 (0.31)			0.04 (0.31)
<i>Partners</i> × <i>ESRI_{it}</i>		0.09 (0.51)			0.05 (0.5)
<i>Position_{it}</i>			0.059 ^p (0.033)	0.11* (0.04)	0.11* (0.043)
<i>Partners</i> × <i>Position_{it}</i>				-0.124 ^p (0.068)	-0.125 ^p (0.068)
<i>N</i>	630	630	630	630	630
R ² adjusted	0.530	0.530	0.533	0.535	0.534
Test F, fixed effects	9.82***	9.17***	6.02***	11.07***	5.5***

^p : p<0,1 / *p<0,05 / ** p<0,01 / *** p<0,001

First of all, fixed effects are always significant (we reject the hypothesis that coefficients of Players dummies are zero). So the fixed effects model is better than an OLS regression.

All the regressions show that the *ESRI_{it}* variable is far from being significant. However, this variable is a proxy for Player's *i* belief on other's future behavior with respect to her own contribution. This variable may then be non significant because the proxy does not really describe what Players guess⁶. It would then be very useful to ask Players, before they choose their contribution, what they guess about future reaction of others players to their own contribution. It is quite different of the work of Croson (2007), because she asked for what players guess about others future contribution, whereas we are interested in what players think about how others people will react to their own contribution. However, Croson (2007) showed a positive relationship between a subject's guess of what other Players will contribute and his own contribution.

⁶ As we assumed that *ESRI*=0 for periods 2 and 3, and as *ESRI_{it}* should not be significant at the last period of the game, we also estimated these models for periods 4 to 9. *ESRI_{it}* is never significant, for instance if we consider the regression 2, estimated coefficient of *ESRI_{it}* is 0.08, (std dev 0.45) ; and estimated coefficient for *Position_{it}*×*ESRI_{it}* is 0.34 (std dev 0.069) for periods 4 to 9. We also try another proxy variable, which corresponds to myopic beliefs and is equal to :

$$myopic_{i,t} = \frac{Contrib_{-i,t-1} - Contrib_{-i,t-2}}{Contrib_{i,t-3} - Contrib_{i,t-4}} \text{ for } t \geq 4 \text{ and } 0 \text{ otherwise. This variable is also not significant.}$$

Position variable is significant and its coefficient in the regression is positive. So, when individual i contributes less than others (in average) in one period, her contribution will get smaller in the next period. A contrario, if she contributes more than others (in average), her contribution will increase in the next period. In the former case, players enjoy from contributing more than others, whereas in the latter players enjoy from contributing less than others.

An interesting result of our econometric analysis is the significance of the slope dummy variable $Partners \times Position_{it}$. This variable can be interpreted as a reciprocity term. In the case a Partner player contributed more (respectively less) than other players of the group on average at the previous period, he will reduce (respectively increase) his actual contribution level in comparison to the Stranger player. In other words both the Stranger and Partner players have positional preferences, but the Partner player adjusts his actual contribution level according to his previous relative contribution: he might either adopt punishment behavior (if having contributed more than others) or reward behavior (if having contributed less than others). However, this reciprocity effect is stronger than the pure positional one : the sum of the coefficients of « $Position_{it}$ » and of « $Partners \times Position_{it}$ » variables is negative.

Concluding remarks

We set up a theoretical model of consumer behaviour which allows to analyse how positional concerns modify the voluntary participation to public goods and they interact with strategic behaviour. An econometric analysis of the Andreoni's results of the Partners/Strangers experiment (Andreoni, 1988) shows that positional concerns do matter in consumer choices. However, reciprocity behaviour being in conflict with positional behaviour leads to inverse effects in Partners' experiment than in Strangers one.

Rajouter conclusion sur réflexions politiques ? limites de l'analyse effectuée ?

Appendix 1.

Proposition 3 : Optimal contribution to the public good at period $t < T-1$ depends on :

- reciprocity behavior (α_i),

- on Expected Strategic Return of Investment (ESRI) :

$$\left(\frac{\partial E_{i,t}(E_{i,t+1} x_{j,t+1})}{\partial x_{i,t}} + \frac{\partial E_{i,t}(E_{i,t+1}(E_{i,t+2} x_{j,t+2}))}{\partial x_{i,t}} + \dots + \frac{\partial E_{i,t}(E_{i,t+1}(\dots(E_{i,T} x_{j,T})))}{\partial x_{i,t}} \right).$$

$$x_{i,t}^* = 0 \text{ if } \forall x_{i,t} \in [0, \frac{D}{p}], \left(-p + \frac{G}{N} + \alpha_i\right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right) ESRI(x_{i,t}) < 0$$

$$x_{i,t}^* = \frac{D}{p} \text{ if } \forall x_{i,t} \in [0, \frac{D}{p}], \left(-p + \frac{G}{N} + \alpha_i\right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right) ESRI(x_{i,t}) > 0$$

$$\text{else, } 0 < x_{i,t}^* < \frac{D}{p} \text{ and such that } \left(-p + \frac{G}{N} + \alpha_i\right) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right) ESRI(x_{i,t}^*) = 0$$

Proof

Optimal choice at the date t is such that :

$$\text{Max}_{x_{i,t}} E_{i,t} \left\{ U_{i,t}(x_{i,t}, x_{j,t}) + E_{i,t+1} \left[U_{i,t+1}(x_{i,t+1}^*, x_{j,t+1}) + E_{i,t+2} \left(U_{i,t+2}(x_{i,t+2}^*, x_{j,t+2}) + E_{i,t+3} (\dots + E_{i,T} U_{i,T}(x_{i,T}^*, x_{j,T})) \right) \right] \right\}$$

From which, it comes :

$$\text{Max}_{x_{i,t}} \left((T-t+1)D + \left(-p + \frac{G}{N} + \alpha_i\right) (x_{i,t} + \sum_{h=t+1}^T x_{i,h}^*) + \left(\frac{G}{N} - \frac{\alpha_i}{N-1}\right) \left[E_{i,t} x_{j,t} + E_{i,t} (E_{i,t+1}(x_{j,t+1})) + E_{i,t} (E_{i,t+1}(E_{i,t+2} x_{j,t+2})) + \dots \right] \right)$$

By derivation, we find previous proposition.

Appendix 2 : Random effects model

We estimate the model :

$$Contrib_{it} = Cons + \beta_1 Position_{it} + \beta_2 ESRI_{it} + \beta_3 Partners + \beta_4 Period + \sum_k \lambda_k Group_k + \alpha_i + \varepsilon_{it}$$

where $Group_k$ is a dummy equal to 1 when Player i belongs to group k, and 0 otherwise, and α_i is a random variable.

Models have been estimated with PROC TSCSREG (SAS), which calculates the Hausman's test value. Next table reports the results (periods 2 to 10).

	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5
<i>Intercept</i>	30,02*** (3,01)	29,95*** (2,99)	29,86*** (2,56)	29,79*** (2,55)	129,79*** (2,55)
<i>Period</i>	-1,74*** (0,17)	-1,74*** (0,17)	-1,74*** (0,17)	-1,74*** (0,17)	-1,74*** (0,17)
<i>Partners</i>		-17,4** (5,52)		-17,19*** (4,24)	-17,28*** (4,22)
<i>ESRI</i>	0,106 (0,232)	-0,025 (0,29)			0,028 (0,28)
<i>Partners×ESRI</i>		0,36 (0,48)			0,42 (0,47)
<i>Position</i>			0,178*** (0,03)	0,23*** (0,04)	0,23*** (0,04)
<i>Partners×Position</i>				-0,13** (0,06)	-0,133** (0,065)
<i>Dummies for groups (suppressed)</i>					
<i>N</i>	630	630	630	630	630
<i>R² adjusted</i>	0,149	0,149	0,193	0,197	0,197
<i>Test Hausman, random effects</i>	17,61	23,14	119,26	119,6	222,8

p: p<0,1 *p<0,05 **p<0,01 ***p<0,001

As the PROC TSCSREG does not allow for restrictions, the coefficient of Partners dummy corresponds to one group of the Partners Players.

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