



# Altruistic Behavior Under Incomplete Information

Friedel Bolle

Alexander Kritikos

---

European University Viadrina Frankfurt (Oder)  
Department of Business Administration and Economics

Discussion Paper No. 229

2005

ISSN 1860 0921

---

# Altruistic Behavior

## Under Incomplete Information

Friedel Bolle and Alexander Kritikos

Europa Universität Viadrina Frankfurt (Oder)

August 2004

**Abstract:** Models to the issue of altruism which rely on externalities of well-being are rarely used explicitly. In this paper we compare such utility-based approaches with the standard approach on altruism which is based on externalities of income. Testable differences of both types of models are derived in the case of incomplete information. More specifically, applied to the Dictator Game and the Impunity Game both played under incomplete information, the utility-based based approach predicts dictators to change their behavior in comparison to Dictator Games under complete information. Under the income-based approach, behavior should not differ in the three versions of the Dictator Game.

Keywords: Altruism, Incomplete Information, Consistent Expectations

JEL No: D64, D82

Europa Universität Viadrina  
LS für Volkswirtschaftslehre,  
insbesondere Wirtschaftstheorie  
(Mikroökonomie)  
Große Scharnstraße 59  
15230 Frankfurt (O)  
Tel. 0335/5534-2289, Fax 0335-5534-2390  
e-mail: [kritikos@euv-frankfurt-o.de](mailto:kritikos@euv-frankfurt-o.de)

### I. Introduction

The fact that people are willing to help other people in real-life circumstances (e.g. by anonymously contributing to charities after situations of distress) is seen as classical example

for the existence of altruism among human beings. Since the laboratory experiments on the Dictator game, where about 2/3 of the subjects give away - under complete anonymity - 20% to 50% of their endowment,<sup>1</sup> altruistic motives gained further prominence as an explanation for these observations.<sup>2</sup> However, doubts were also raised against the interpretation that participants were making transfers to anonymous others for altruistic reasons. In particular Bolton and Zwick (1995) and later on Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) attributed other fairness related motives to these choices.<sup>3</sup>

In this paper we aim to offer a different perspective. Instead of searching for further motives beyond the egoistic “homo oeconomicus” model of man, we aim to analyze more deeply the existing models on altruistic behavior. Most approaches modelling altruistic choices have focused on material outcomes for donators and recipients. According to these models (which we will call models of income-based altruism) the donator aims at increasing the income of the recipient (see for instance Collard (1978) or Andreoni and Miller (2002)). In contrast to this, in Becker’s model (1974) and also in Barro (1974) it is assumed that altruistic moves aim at increasing the utility of the recipient (which we will call the utility-based model).

In order to clarify the differences between the two approaches this paper, we analyse their implications under incomplete information. In a second step we will derive new hypotheses for behavior in laboratory experiments. These may allow to answer the crucial question whether it is indeed altruism which guides behavior in certain experiments. According to the present analysis, it will turn out that in Dictator Games the information status of the participants is of importance. We will show in the rest of the paper that depending on whether objective “facts” (income) or “happiness” (utility) of others determine behavior, the information status will have an impact on the choices of altruistically motivated persons.

In Section II, the two approaches are compared on the basis of simple scenarios. In Section III, we will discuss the formation of *consistent expectations* of the others’ utilities. Section IV provides examples of this formation and show how the approaches can be experimentally tested. Section V discusses the question of “amplifying” is “dampening” altruism. Section VI concludes.

## **II. Income- and Utility-based altruism**

In terms of utility theory, altruistic behavior is caused by external effects. There are, as mentioned in section I, two main approaches which differ in the origin of the externalities. In

---

<sup>1</sup> See e.g. Forsythe et al (1994) whose experiment has become a benchmark in the meantime.

<sup>2</sup> Besides Forsythe et al. (1994) it was Eckel and Grossman (1996), Andreoni and Vesterlund (2001) and Andreoni and Miller (2002) who favored this interpretation of the experiments.

<sup>3</sup> Further, Hoffman et al. (1994), Güth and Huck (1997) and Bolton et al. (1998) suggested different kind of interpretations for this behavior in the Dictator game.

most approaches it is assumed that a person's utility is influenced either by other persons' consumption of goods or by other persons' income.

$$(1) \quad U_i = V_i(x_1, \dots, x_i, \dots, x_n), \quad i = 1, \dots, n, \quad \text{with } x_j = \text{income (or consumption) of person } j.$$

where  $x_i$  represents  $i$ 's consumption, and  $x_1, \dots, x_n$  represent the consumption of individuals  $j$  with whom person  $i$  interacts. Given (1) and  $\partial U_i / \partial x_j > 0$ ,  $i$ 's utility is increased if  $j$  enjoys a higher income. If the cost/benefit relation  $\Delta x_i / \Delta x_j$  is small enough,  $i$  will carry out a "helping act"  $(\Delta x_i, \Delta x_j)$ , which results in incomes  $x_i - \Delta x_i$  and  $x_j + \Delta x_j$ . If  $\partial U_i / \partial x_j < 0$   $i$  is ready to incur cost to decrease  $x_j$ . Examples of the income based approach are the fairness theories of Bolton and Ockenfels (2000) and Fehr and Schmidt (1999).

Instead of this, Gary Becker (1974) has proposed a utility-based setting:

$$(2) \quad U_i = U_i(x_i, U_1, \dots, U_{i-1}, U_{i+1}, \dots, U_n), \quad i = 1, \dots, n,$$

where  $U_1, \dots, U_{i-1}, U_{i+1}, \dots, U_n$  represent the utilities of individuals  $j$  with whom altruist  $i$  interacts. If  $\partial U_i / \partial U_j > 0$   $i$ 's utility is increased if  $j$ 's utility ( $j \neq i$ ) is increased or  $i$  is 'happy' if  $j$  is 'happy'. The contrary applies if  $\partial U_i / \partial U_j < 0$ .

The central question in approach (2) is now how  $i$  receives information about the utilities  $U_j$ ,  $j \neq i$ . In Scenarios 1 and 2, we will start with extreme assumptions with respect to this question.

**Scenario 1 (complete information):** All individuals know all  $x_i$  and all functions (2). They determine (compute) equilibrium values of  $U_j$  from the system of equations (2).

Scenario 1 is the most simple case and serves to discuss the nature of utilities in the approach (2). On the one hand, under the utility-based approach seemingly unrelated utility functions may turn out to be equivalent from the viewpoint of decision making. Examples are, in the two person case,  $U_i = a_i x_i + b_i U_j$  and  $U_j = e^{a_j x_j} (U_i)^{b_j}$ .

On the other hand, utilities in (2) have to be nearly absolute measures of well-being. While in (1), every utility function can be separately transformed by an arbitrary increasing transformation (under certainty) or at least by an arbitrary increasing linear transformation (under uncertainty), a transformation like this is not possible in (2).  $U_i = a_i x_i + b_i U_j$ ,  $i \neq j$ ,  $i$ ,

$j = 1, 2$  is different from  $U_i' = x_i + \frac{b_i}{a_i} U_j'$  which becomes apparent when the equations are solved to get to (1).

**Scenario 2 (no information, truthful signalling):** Every individual  $i$  knows  $x_i$ ,  $i$  does neither know  $x_j$ ,  $j \neq i$ , nor the function (2) by which the utilities of others are determined. Instead,  $i$  receives signals about  $U_j$ ,  $j \neq i$ . If signals are truthful, an adaptation process may result in the equilibria of Scenario 1.

Bolle (1991) discusses necessary and sufficient conditions for the convergence of this adaptation process. However, the existence of a world with truthful signals is unrealistic.<sup>4</sup> More importantly, the two extreme Scenarios 1 or 2 mostly lead to a unique vector of utilities, i.e.  $(x_1, \dots, x_n)$  determines  $(U_1, \dots, U_n)$  or equation (2) determines equation (1), making it seemingly unnecessary to use the less tractable utility-based approach.<sup>5</sup>

In a dynamic world under incomplete information, the utility-based approach has completely different implications than the income-based approach. (1) depends on “objective” income only, not on “subjective” utility (well-being) of others. Thus, the utility of  $i$  does not change under (1) if the income vector is preserved while the utility function of others is altered. Under (2), the utility of  $i$  as well as the derived system of (1) are subject to changes. Thus, under incomplete information about the other’s utility function, we have a variability which evokes the true differences between the approaches.

To explain it more formally: Assume that the utility functions in (2) stem from a certain family of functions which is indicated by the dependence of  $U_i$  not only on  $x_i$  and  $U_j$ ,  $j \neq i$ , but also on a parameter  $a_i$ . If we now compute  $V_i$  of (1) from the system (2), we will find that  $V_i$  depends also on  $a_j$ ,  $j \neq i$ , i.e. on the parameters of others.<sup>6</sup>

Firstly, however, we have to have a closer look on the formation of expectations under the utility-based approach.

---

<sup>4</sup> While Collard’s (1978) interpretation is that people wear utility meters in their face, Bergstrom (1989) mocks about such an assumption by painting Romeo and Juliet as having gauges with pointers directly above their navels indicating their status of happiness.

<sup>5</sup> Nevertheless, under complete information and in a static world, Becker’s approach (1974) provides us with some plausible restrictions on the system (1). Firstly, the friend of my friend as well as the enemy of my enemy are my friends. Secondly, altruism within a group can be caused not only by “loving ties” within this group but also by loving or even by hateful ties to another group. For these and other implications of the utility-based approach, see Bolle (1991).

<sup>6</sup> Levine (1998) starts his investigation with a similar utility function. However, in contrast to us, he does not trace back his model to the utility-based approach.

### III. Consistent expectations

In Scenario 1, individuals have to “compute” the utilities from system (2), i.e. they develop expectations about the utilities of all  $j \neq i$  which again determine their own utilities. Let  $E_i U_j$  denote the expectations of  $i$  about the utility of  $j$ . If we now also focus on a third individual  $k$ , then  $k$  has not only to develop expectations  $E_k U_i$  but also  $E_k E_i U_j$ , i.e. expectations about the expectations of  $i$ , etc. In our “computation” we have implicitly assumed that  $E_i U_j = E_k E_i U_j = E_n E_k E_i U_j = \dots = E U_j$ . If this is true, we will call these values “consistent expectations”. In particular it is required that  $j$  anticipates  $i$ 's expectation formation  $E U_j$ . If all have complete information, individuals will have utilities  $U_j = E U_j$  assuming that there is only one “solution” of system (2).

Under incomplete information, matters are more complicated.

**Scenario 3 (private information about independently varying income):** The functional forms (2) are common knowledge, income  $x_i$  is private knowledge of  $i$ . In particular, the functional forms are

$$(3) \quad U_i = \sum_k y_{ik}(x_i) P_{ik}(u_{-i}), \quad U_{-i} = (U_1, \dots, U_{i-1}, U_{i+1}, \dots, U_n).$$

$\mathbf{x} = (x_1, \dots, x_n)$  is a random variable with the distribution function  $F_1(x_1) \cdot \dots \cdot F_n(x_n)$ ,  $i$  knows  $x_i$ , but not  $\mathbf{x}_{-i} = (x_1, \dots, x_{i-1}, x_{i+1}, \dots, x_n)$ .

Assume that  $i$  forms *consistent expectations*  $EP_{ik}$  and that all players draw the same conclusion about  $i$ 's expectation  $EP_{ik}$ . Then, it is possible to compute the  $EP_{ik}$  values. In all equations (3)  $P_{ik}(U_{-i})$  are substituted by  $EP_{ik}$ . This leads to

$$(4) \quad EP_{ik} = \int P_{ik}(U_{-i}) dF(x_1) \dots dF(x_{i-1}) dF(x_{i+1}) \dots dF(x_n) \text{ for all } i, k.$$

The functions of  $P_{ik}(U_{-i})$  are independent of  $x_i$ . Thus, (4) is a system of equations for constant values  $EP_{ik}$ .

It should be added that, if we vary Scenario 3, i.e. if we assume that the parameters of the functions (2) are private knowledge, the outcome is the same.

**Remarks:** 1) After a deviation from complete information,  $U_i$  is usually different from  $E U_i$ , the utility which all others expect  $i$  to have. 2.) The approach in this section allows for a certain amount of asymmetric information.  $F_i(x_i)$  may be different from  $F_j(x_j)$ ,  $j \neq i$ . It

cannot express, however, that  $j$  is better informed about  $x_i$  than  $k$ . 3) The assumption that parameters of the functions (2) are private knowledge is no principle difference to Scenario 3.

**Scenario 4 (Signalling):** If actions of an individual  $i$  can be observed by all other individuals, then these individuals are able to derive conclusions about the income  $x_i$  or about the parameters of  $U_i$ . After an action of  $i$ ,  $x_i$  may be common knowledge, or the action may serve to “update” the distribution  $F_i(x_i)$ , or the distribution of other parameters.

In Scenarios 3 and 4 we assumed independent private income and/or parameter values (comparable to independent private values in auctions). Giving up this assumption has the consequence that consistency as defined in this section does not exist any longer. In the Appendix, we will outline how cases of dependent values should be handled by the introduction of “second order” consistency.

**Scenario 5 (A special case of asymmetric information):** Assume that  $x_i$ ,  $i=1, \dots, m$  are common knowledge while  $x_i$ ,  $i=m+1, \dots, n$  are private information.

Under these circumstances, let us further assume that  $U_i = EU_i$  for  $i=1, \dots, m$ , i.e. the other individuals have correct expectations about the utility of  $i$ . For the other  $U_i$  we form consistent expectations as demonstrated above.  $EP_{ik}$ ,  $i=m+1, \dots, n$  are now functions of  $x_1, \dots, x^m$ .

For all other cases than those described, it seems to be necessary to derive higher order consistent expectations. An example is given in the Appendix.

## IV. Applications of the utility-based Approach

### IV. 1: The dictator game with asymmetric information about the pie size

In the usual Dictator Game under complete information, one person (the dictator  $D$ ) is endowed with a known amount of money (a pie of size  $P$ ) which he can divide arbitrarily between himself by keeping  $x_D$  and Person 2 (the recipient  $R$ ) by transferring  $x_R$ . In the variation, we will analyze here, the Dictator Game is changed insofar as the dictator is endowed again with an amount  $P$  where the pie size is known to the Dictator. The recipient is not informed about the size. She only knows the distribution of possible pie sizes.

According to the income-based approach, the dictator has no reason to condition his behavior on the information status of the recipient. He will transfer always the same amount  $x_R$ .

According to the utility-based approach (2) the dictator may have reason to condition his decision on the information status of the recipient. However, to be able to show this, it is necessary to further specify the utility functions described in (2), since these are too general to be useful for the Dictator Game (and later in this paper for the Impunity Game). Therefore,

we will introduce a specification of this approach, which is based on earlier research on equity theory and which fits into this class of games. Consider the following utility functions

$$(9) \quad U_D = x_D + a_D (x_D - s_D) U_R, \quad a_D, s_D > 0$$

$$(10) \quad U_R = x_R + a_R (x_R - s_R) U_D, \quad a_R, s_R > 0$$

which consist of an egoistic and an altruistic term.<sup>7</sup> According to earlier psychological research on equity theory (e.g. Walster et al. (1978)) and on the theory of justice (e.g. Mikula (1983) and Reis (1983)) we further suppose that individuals have altruistic motives as long as their actual income is higher than a certain minimum income of  $s_i$ .<sup>8</sup>

The recipient's income  $x_R$  stems from the dictator transfer:

$$(11) \quad x_D = P - x_R,$$

Let us proceed with the analysis of a simplified Dictator Game under incomplete information. Suppose that there are only two sizes; the dictator is endowed either with  $P_L$  with  $Prob = \alpha$  or with  $P_S < P_L$  with  $Prob = 1 - \alpha$ . The Dictator knows his actual pie size while the recipient is informed only about the probability distribution. In addition, assume that the dictator has only one choice in the case of a small pie, namely the equal split ( $x_R = P_S/2$ ). In the case of the large pie, he has only two choices,  $x_R = P_S/2$  or  $x_R = P_L/2$ . To further simplify the problem, we suppose all parameters of the utility functions to be common knowledge. The dictator is assumed to make his decision when he knows the pie size.<sup>9</sup> The only decision the dictator has to make in case of the large pie ( $P=P_L$ ) is whether to give  $P_L/2$  or  $P_S/2$ . Thus, the dictator has two strategies. Strategy I: always  $x_R = P_S/2$ . Strategy II: always equal division  $x_R = P/2$ .

With respect to the recipient, we suppose that she anticipates the dictator's strategy. Further assuming that the Dictator uses a pure strategy, the recipient will do the following conjectures: If she receives  $P_L/2$  she knows that  $P = P_L$ . If she gains  $P_S/2$  and if the dictator chooses  $x_R = P/2$  then she knows that  $P = P_S$ . If she gets  $P_S/2$  and if the dictator's strategy is always  $x_R = P_S/2$  then she assumes  $P = P_L$  with  $Prob = \alpha$ . In the latter case, she estimates

$$(12) \quad EX_D = \alpha (P_L - P_S/2) + (1 - \alpha) P_S/2 \\ = \alpha P_L + (1 - 2\alpha) P_S/2.$$

<sup>7</sup> These utility functions are very simple. They will serve only for numerical examples. It is obviously possible to switch from absolute to relative or, more generally, "normalised" income where the normalisation procedure has to be discussed explicitly.

<sup>8</sup> Similar assumptions are the basis of the fairness theories of Bolton and Ockenfels (2000) and Fehr and Schmidt (1999).

<sup>9</sup> The problem changes if the dictator is able to commit in advance to a strategy.



We may compute the alternative utilities (if  $P = P_L$ ) under the pure Strategy I ( $x_R = P_S/2$ ) and the pure Strategy II ( $x_R = P/2$ ). In both cases we assume that all parameters of (9) and (10) are common knowledge. Using (3) and (4), we are able to calculate the utility  $U_R = U_R(x_R)$  which is common knowledge and  $U_D = U_D(x_D)$  which is private knowledge ( $R$  only knows  $EU_D$ ).

We obtain<sup>10</sup>

$$(13) \quad U_R = EU_R = \frac{x_R + a_R(x_R - s_R)Ex_D}{1 - a_D a_R(Ex_D - s_D)(x_R - s_R)}$$

$$(14) \quad U_D = x_D + a_D(x_D - s_D)EU_R.$$

We have to insert  $Ex_D = x_D = x_R = P_L/2$  under Strategy II and  $P = P_L$ ,  $x_D = P_L - P_S/2$ ,  $x_R = P_S/2$  and  $Ex_D$  from (12) under Strategy I.

It is possible to show that there are cases where Strategy I is chosen and cases where Strategy II is optimal for the dictator.<sup>11</sup> The crucial point is that, only under the utility-based approach, Strategy II might be optimal when the recipient has complete information and Strategy I when she has incomplete information. We prove this proposition by a numerical example.

If  $P_L = 6$ ,  $P_S = 2$  and  $\alpha = 0.25$  then  $Ex_D = 2$  if the dictator transfers  $x_R = P_S/2 = 1$ . Assume in addition,  $a_D = a_R = 0.4$  and  $s_D = s_R = 2$  then (13) and (14) imply

$$(15) \quad U_D^I = 5 + 0.4(5 - 2) \frac{1 + 0.4(1 - 2) \cdot 2}{1 - 0.16(2 - 2)(1 - 2)} = 5.24.$$

(15) shows the utility the dictator enjoys when he is endowed with the large pie and uses Strategy I. Using Strategy II, he gets  $x_D = Ex_D = 3$ , which results in the utility

$$(16) \quad U_D^{II} = 3 + 0.4(3 - 2) \frac{3 + 0.4(3 - 2) \cdot 3}{1 - 0.16(3 - 2)(3 - 2)} = 5.$$

Under complete information, the value of Strategy II remains the same. The value of Strategy I changes because of  $Ex_D = x_D = 5$ . This leads to

$$(17) \quad U_D^I (\text{complete information}) = 5 + 0.4(5 - 2) \frac{1 + 0.4(1 - 2) \cdot 5}{1 - 0.16 \cdot (5 - 2) \cdot (1 - 2)} = 4.19.$$

<sup>10</sup> This shows, once more, the pivot of coping with incomplete information in this model.  $R$  does not know  $U_D$ , she has to form a (consistent) expectation  $EU_D$ . This *firm value* enters  $R$ 's utility function and  $EU_R$  is computed under the condition of a firm value  $EU_D$ .

<sup>11</sup> In order to show that a pure Strategy II is optimal it is not sufficient to show that  $U_D$  is higher under Strategy II than under Strategy I. If the recipient expects the dictator to play the pure Strategy II then the dictator may be tempted to offer  $P_S/2$  if he is endowed with  $P = P_L$ , trying to exploit the recipient's (erroneous) expectation  $x_D = P_S/2$ . Only if this offer is also inferior to playing Strategy II, strategy II is really played. Otherwise a mixed strategy will emerge where the choices of  $x_R = P_S/2$  as well as of  $x_R = P_L/2$  have the same value  $U_D$ .

**Conclusion 1:** The utility-based approach expects some Dictators to choose Strategy I when there is asymmetric information about the pie size, and to prefer Strategy II under complete information. This result provides us with a simple possibility to test the two approaches to altruism by comparing behavior in Dictator Games with and without complete information.

#### IV. 2: The Impunity Game

In this section, we further compare the two approaches by focusing on another variation of the Dictator Game, the Impunity Game (of Bolton and Zwick (1995)). In the Impunity Game the dictator is endowed with a known amount of money which he may again divide between the recipient and himself. The recipient is given the choice to either accept or decline the dictator's offer. In the latter case  $x_R$  is lost and not given back to the dictator. The dictator, however, can keep his own share  $x_D$  irrespective of the choice of the recipient. The crucial question is now whether any of the altruistic approaches will predict that a recipient might be willing to "throw away" any positive amount transferred to him and how a Dictator might react according to these models if he anticipates such a behavior.

Using again the utility functions of (9) and (10), in this case  $x_D$  and  $x_R$  are common knowledge. In the Impunity Game it is now the Dictator who has to make a decision under incomplete information. Therefore, assume that  $s_R$  is private knowledge of  $R$ . For the sake of simplicity, assume all other parameters to be common knowledge. Following the procedure of section III, we get

$$(18) \quad U_D = EU_D = \frac{x_D + a_D(x_D - s_D)x'_R}{1 - a_D a_R(x_D - s_D)(x'_R - Es_R)}$$

$$(19) \quad U_R = x'_R + a_R(x'_R - s_R)EU_D$$

with  $x'_R = x_R$  if the recipient accepts the transfer and  $x'_R = 0$  if the recipient rejects her share of the pie.  $Es_R$  is the conditional expectation resulting from the decision of the recipient. When the dictator has to decide, he has to take into account both possibilities of the recipient, acceptance and rejection.

If  $x'_R < s_R$  then (19) implies that the recipient aims to decrease the utility of the dictator ( $EU_D$ ) which is why she will decide to reject the transfer ( $x'_R = 0$ ). If

$$(20) \quad U_R(x'_R = 0) = -a_R \Delta_R \frac{x_D}{1 + a_D a_R(x_D - s_D)E(s_R / x'_R = 0)}$$

$$> x_R + a_R(x_R - s_R) \frac{x_D + a_D(x_D - s_D)x_R}{1 - a_D a_R(x_D - s_D)(x_R - E(s_R / x'_R = x_R))} = U_R(x'_R = x_R)$$

Assume that the minimum income requirement of the dictator is  $s_D=P/2$  and of the recipient is  $s_R=0$  with  $Prob=\alpha$  and  $s_R=P/2$  with  $Prob=1-\alpha$ . ( $P$  is again the size of the pie). The dictator will always give less than half the pie. If  $s_R=0$ , the recipient will never reject a positive  $x_R$ , thus

$$(21) \quad E(s_R / x'_R = 0) = P/2.$$

If  $x_R$  is so small that it would only be accepted by recipients with  $s_R=0$  then

$$(22) \quad E(s_R / x'_R = x_R) = 0.$$

If  $x_R$  is large enough to be accepted even by recipients with  $s_R = P/2$  then

$$(23) \quad E(s_R / x'_R = x_R) = (1-\alpha)P/2.$$

There exist two possible types of equilibria with pure strategies  $x'_R$ . A separating equilibrium with  $x'_R = 0$  if  $s_R = P/2$  and  $x'_R = x_R$  if  $s_R = 0$ , and a pooling equilibrium  $x'_R = x_R$ . A special case of the pooling equilibrium is  $x_R = 0$ .

There are two critical values  $x_R^{separating} < x_R^{pooling}$  where (20) becomes an equality given (22) and (23). In this case  $0 < x_R \leq x_R^{separating}$  induces the separating equilibrium and  $x_R \geq x_R^{pooling}$  induces a pooling equilibrium. Formally, also  $x_R = 0$  provides us with a pooling equilibrium. For  $x_R^{separating} < x_R < x_R^{pooling}$  there are mixed strategy equilibria.

By backward induction, we are able to determine the optimal choice  $x_R$ . If  $\alpha$  - the probability of being matched with a recipient with a low  $s$  - is small enough then the risk of being involved in a separating equilibrium may be too high for the dictator. In this case he will decide for  $x_R = 0$ .

**Conclusion 2:** The utility-based approach as specified in equations (9) and (10) predicts that recipients may “burn” transfers when these are smaller than their minimum requirement  $s_R$ . Since a rejection would decrease the utility of dictators, this approach also predicts that dictators will decide differently if they anticipate such behavior. In comparison to the standard Dictator Game where many dictators transfer small amounts to their recipients, in the Impunity Game they will tend to transfer either nothing or more than in the Dictator Game. The income-based approach does not predict any difference to the standard Dictator Game.

## V. Amplifying and dampening altruism

So far our approach was focused on rather static games (the Dictator Game and its variations) where the dictator is influenced by the recipient’s decision only indirectly. These games are, therefore, the purest test for altruistic motives, since a person is able to express his willingness to reduce his own level consumption in order to change the utility of a fellow person.

In earlier research it was also suggested that altruistic behavior could be a principle motive in dynamic games, as well. The observations in the Centipede Game (see McKelvey and Palfrey (1992)) or other laboratory experiments involving mutual exchange processes (see Fehr and Fischbacher (2003) underlined that altruism could be the baseline for co-operative behavior in later stages of these games with more than one stage.<sup>12</sup> The suggestion was rejected by many experiments involving the sequential Prisoners' Dilemma (cf. e.g. Bolle and Ockenfels (1990), Clark and Sefton (2001)) where second movers do not co-operate when first movers defected, and the Ultimatum Game (cf. e.g. Güth et al. (1996)) where respondents reject unfair splits.<sup>13</sup> These observations indicated that in some dynamic games where decisions are embedded in a strategic setting, different motives (such as positive or negative reciprocity, *induced* envy or inequity aversion) prevail.

Therefore, it might be worth to further analyse linkages between altruism and reciprocity within the present framework. In the utility-based approach, the propensity of a Person 1 to help a Person 2 depends on the expectations of Person 1 about the intention of Person 2 to help Person 1. This is a form of implicit reciprocity which does not depend on real but on expected actions. We will further call this *amplifying altruism*.

In the following, we will discuss to what extent amplifying altruism may exist in static settings when two persons are involved. If the altruism function (2) is concerned with  $x_i =$  total income of  $i$  instead of  $x_i =$  income change (income distributed in an experiment or income from a certain business transaction) then, in most cases, it is appropriate to linearize (2) under the assumption of small possible income changes  $\Delta x_i$ .

$$(24) \Delta U_1 = a_1 \Delta x_1 + b_1 \Delta U_2.$$

$$(25) \Delta U_2 = a_2 \Delta x_2 + b_2 \Delta U_1.$$

Assume for both individuals a one-parametric family of (linearised) utility functions  $a_i = a_i(b_i)$  and  $b_1 b_2 < 1$  in order to prevent "excessive altruism".<sup>14</sup> Then, we get under complete information:

$$(26) \Delta U_1 = \frac{a_1 \Delta x_1 + b_1 a_2 \Delta x_2}{1 - b_1 b_2},$$

---

<sup>12</sup> Cf. Levine (1998) who based his approach on these experimental results.

<sup>13</sup> Interestingly, when dictators had to make the same decisions in binary choice dictator games as the respondents in the Ultimatum Game, (e.g. the choice between an unequal splits in favor of the other player or a zero payoff for both players), many distributions were accepted in the Dictator Game which were rejected in the strategic setting of the Ultimatum Game (see Kritikos and Bolle (2001)).

<sup>14</sup> See Collard (1978) for the „after you“ problem and Bolle (1991) for a generalisation of this condition in the n person case.

$$(27) \Delta U_2 = \frac{a_1 \Delta x_2 + b_2 a_1 \Delta x_1}{1 - b_1 b_2}.$$

Person 1 prefers an action connected with  $(\Delta x_1, \Delta x_2)$  to the decision of ‘no action’ connected with  $(\Delta x_1', \Delta x_2') = (0, 0)$  if  $a_1 \Delta x_1 + b_1 a_2 \Delta x_2 > 0$ , or if the price  $-\Delta x_1 / \Delta x_2$  is lower than the marginal rate of substitution  $\frac{b_1 a_2}{a_1}$ . A “helping act” is one with  $\Delta x_1 < 0$ ,  $\Delta x_2 > 0$ ; a punishing act results in  $\Delta x_1 < 0$  and  $\Delta x_2 < 0$ .

If we further assume  $a_i > 0^{15}$ , the assumption of Person 1 being altruistic then leads to  $b_1 > 0$ . If  $\partial \frac{b_2 a_1}{a_2(b_2)} / \partial b_2 > 0$  then, with increasing  $b_2$  Person 2’s altruism extends. If such a parametrization exists for Person 2, altruism in Person 1 is amplified, if  $\partial a_2 / \partial b_2 > 0$ . The reason is that the marginal rate of substitution  $\frac{b_1 a_2}{a_1}$  increases, i.e. 1’s altruism increases when 2’s altruism increases. If  $\partial a_2 / \partial b_2 < 0$  then 2’s altruism causes a dampening effect.

**Examples:**  $a_i = 1 + b_i$ ,  $i = 1, 2$ , is an example of amplifying altruism.

$a_i = 1 - b_i$  is an example of dampening altruism.

$a_i = 1$  implies “neutral” altruism not being affected by the other’s altruism.

When analysing the same approach under incomplete information, we will see that there is an additional effect. Assume  $\Delta x_i$  to be private knowledge while  $a_i$  and  $b_i$  are be common knowledge. We have, first of all, again to determine consistently expected utilities, which are

$$(28) E\Delta U_1 = \frac{a_1 E\Delta x_1 + b_1 a_2 E\Delta x_2}{1 - b_1 b_2}.$$

The utility change which Person 1 enjoys is

$$(29) \Delta U_1 = a_1 \Delta x_1 + b_1 E\Delta U_2.$$

Disregarding in a first step the signalling properties of an act, if  $\Delta U_1 > 0$ , Person 1 carries out an act connected with costs  $\Delta x_1$  (which he knows) and benefits  $\Delta x_2$  (of which Person 1 only knows the distribution). This leads to

$$(30) a_1 \Delta x_1 + b_1 a_2 E\Delta x_2 + b_1 b_2 a_1 (E\Delta x_1 - \Delta x_1) > 0.$$

For  $b_2 = 0$ , Person 1 will help Person 2 if the expected utility increase outweighs the cost of Person 1. For  $b_2 > 0$ , also the difference of Person 2’s expectation in comparison with the real cost of Person 1 matters. If Person 2 underestimates the cost of Person 1, Person 1 is ready to

---

<sup>15</sup>  $a_i < 0$  would imply that the respective person has ‘masochistic’ preferences.

carry out acts he would not have carried out under complete information, and vice versa. Thus, there is an incentive not to “disappoint” the other’s expectations.<sup>16 17</sup>

If we take now into account that Person 1 helping Person 2 is a signal for Person 2 that (24) should apply and vice versa, then the expectation value of  $E\Delta x_1$  has to be revised. When (30) applies (under this expectation value), the act is carried out and consistent (conditional) expectations  $E\Delta x_1$  have been determined. Vice versa, when (30) does not apply with revised expectations, the act is not carried out. This leads to a restriction of the above result: The signalling property of an action weakens the incentive to carry out the action. Instead of getting a unique result, when taking the signal of the action into account, no action might be supported by (30). In this case Person 1 will choose a mixed strategy. If this happens for certain  $x_i$ -values, the mixed strategy has to be considered in all updating processes.

## VI. Conclusion and Discussion

Recent experimental evidence has renewed the discussion to what extent non-egoistic human acts could be classified as altruistic. Instead of considering the ‘pros and cons’ of using altruistic models as an explanation for observed behavior, the present paper deepens the understanding of altruistic choices by introducing incomplete information and derives new testable hypothesis for further experiments.

By comparing the two existing approaches– the utility- and the income-based approach to altruism – under incomplete information, we show that there is no unique solution. While the income-based approach always expects an altruistically motivated person to behave in the same way as under complete information, the utility-based approach foresees that incomplete information may change decisions substantially.

More specifically, we showed that, under the precondition of consistent expectations, the utility-based approach expects certain participants of a Dictator Game to reduce their transfers if recipients have incomplete instead of complete information about the pie size. The utility-based approach also expects that in the Impunity Game (where dictators have incomplete information about the acceptance level of the recipients) dictators will either increase or decrease their transfers to zero, if they expect recipients to reject their own share of the pie.

---

<sup>16</sup> Note that the dictator behavior, discussed in IV.I, may also be explained along this line. In the Dictator Game with incomplete information, it is not the price of altruism which is private knowledge but the income of the dictator. For  $1 = D$ , we get  $E x_1 - x_1 = EP - P$ . If the dictator is provided with a large pie, then  $EP - P < 0$  and the dictator will transfer less than under complete information.

<sup>17</sup> All results apply for both persons. Moreover, it is possible to generalize the 2-person bilinear model of this section. Introducing a third person gives rise to another form of amplifying (or dampening) altruism. If a Person 3’s altruism towards 1 and 2 increases then the altruism between 1 and 2 will be amplified (see Bolle (1991)).

First experimental tests (cf. Kritikos and Bolle (2004 a,b)) indicate that the expected subgroup of dictators indeed reduced their transfers in the Dictator Game under incomplete information and increased or decreased their transfers in the Impunity Game – both games compared to the behavior in the Dictator game under complete information. The fact that we observed the predicted *changes* in the behavior of the participants is in support of the utility-based model.

In the last section of the paper we further analysed the consequences of human beings putting themselves in the places of others. We showed that depending on the expectations of an altruistically motivated person about the behavior of his ‘counterparts’ the altruistic choices might be amplified or dampened. We also showed that the effect of amplified altruism might be changed when there is incomplete information about the cost of an altruistic move.

In this context it should be pointed out that amplifying altruism is the main hypothesis of Levine (1998). However, in contrast to the present approach, Levine (1998) directly introduces amplifying altruism in his model without tracing it back to any fundamental theory of altruism. His model, therefore, is not capable of the changes of behavior observed in the modified Dictator Game and in the Impunity Game. Levine (1998) further argues that choices in strategic settings which have a reciprocal component (such as the Ultimatum Game) may also be explained by his approach of amplifying altruism.<sup>18</sup>

Selten and Ockenfels (1998), in their discussion of the 3-person Solidarity Game, conclude with a crucial question which could become the baseline for further tests. They argue that they are not able to distinguish whether “my expectation of the third person’s altruism guides my behavior toward the second person” (which would be in favor of amplifying altruism and which could not be explained by reciprocity) or whether “my behavior guides my expectations about others’ altruism” (which would allow for the existence of ‘correlated expectations’). Future experiments on altruism could answer this indeterminacy.

---

<sup>18</sup> Levine does not separate amplifying altruism from reciprocity. He applies his model also on the Ultimatum Game and on other dynamic games. The high frequencies of spite (70%) which Levine (1998) derives in particular from ultimatum experiments are incompatible with the high frequencies of transferring positive amounts in dictator experiments (cf. Kritikos and Bolle (2001)).

## References

- Andreoni, J.; Miller, J.H. (2002):** “Giving according to GARP: An Experimental Study of Rationality and Altruism”, *Econometrica* 70, 737-753.
- Andreoni, J.; Vesterlund, L. (2001):** “Which is the Fair Sex? Gender Differences in Altruism”, *Quarterly Journal of Economics* 116, 293-312.
- Barro, R.J. (1974):** "Are Government Bonds Net Wealth?", *Journal of Political Economy* 82, 1095-1117.
- Becker, G.S. (1974):** “A theory of social interactions”, *Journal of Political Economy* 82, 1064-93.
- Bergstrom, T. (1989):** “Love and spaghetti: The opportunity cost of virtue”, *Journal of Economic Perspective*: 3, 165-73.
- Bolle, F. (1991):** "On Love and Altruism", *Rationality and Society* 3, 197-214.
- Bolle, F. and Ockenfels, P. (1990):** “Prisoner’s Dilemma as a game with incomplete information”, *Journal of Economic Psychology* 11, 69-84.
- Bolton, G.E.; Katok, E.; Zwick, R. (1998):** “Dictator Game Giving: Rules of Fairness versus Acts of Kindness”, *International Journal of Game Theory* 27, 269-299.
- Bolton, G.E.; Ockenfels, P. (2000):** “A Theory of Equity, Reciprocity and Competition”, *American Economic Review* 90, 166-193.
- Bolton, G.E.; Zwick, R. (1995):** “Anonymity versus Punishment in Ultimatum Bargaining”, *Games and Economic Behavior* 10, 95-121.
- Clark, K. and Sefton, M. (2001):** The sequential Prisoner’s Dilemma: Evidence on Reciprocation, *The Economic Journal* 111, 51-68.
- Collard, D. (1978):** “Altruism and Economy”, *Oxford, Robinson*.
- Eckel, C.; Grossman, P. (1996):** “Altruism in Anonymous Dictator Games”, *Games and Economic Behavior* 57, 16, 181-191.
- Fehr, E. and Fischbacher, U. (2003):** “The nature of human altruism”, *Nature, Vol* 425, 785-791.
- Fehr, E. and Schmidt, K. (1999):** "A Theory of Fairness, Competition and Cooperation", *Quarterly Journal of Economics* 114, 817-868.
- Forsythe, R., Horowitz, J.L., Savin, N.E., Sefton, M. (1994):** “Fairness in Simple Bargaining Experiments”, *Games and Economic Behavior* 6, 347-369.
- Güth, W.; Huck, S.; Ockenfels, P. (1996):** “Two-level Ultimatum Bargaining with Incomplete Information: An Experimental Study”, *Economic Journal* 106 593-604.
- Güth, W.; Huck, S. (1997):** “From Ultimatum Bargaining to Dictatorship – An Experimental Study of Four Games Varying in Veto Power, *Metroeconomica* 48, 262-279.
- Hoffman, E.; McCabe, K.; Shachat, K.; Smith, V. (1994):** “Preferences, Property Rights and Anonymity in Bargaining Games”, *Games and Economic Behavior* 7, 346-380.
- Kritikos, A. and Bolle, F. (2001):** “Distributional Concerns: Equity or Efficiency Oriented?”, *Economic Letters* 73, 333-338.



- Kritikos, A. and Bolle, F. (2004a):** “Utility-Based Altruism: Evidence from Experiments”, in B. Agarwal, A. Vercelli (eds.): *Psychology, Rationality and Economic Behaviour: Challenging Standard Assumptions*, forthcoming.
- Kritikos, A. and Bolle, F. (2004b):** “From Dictatorship to Ultimatum Bargaining – New Evidence on the existence of altruistic motives in Experiments”, Dis. paper, European University Viadrina, Frankfurt (Oder).
- Levine, D. (1998):** “Modelling Altruism and Spitefulness in Experiments”, *Review of Economic Dynamics* 1, 593-622.
- McKelvey, R.D.; Palfrey, T.R. (1992):** “An Experimental Study of the Centipede Game“, *Econometrica* 60, 802-836.
- Mikula, G. (1983):** “Justice and Fairness in Interpersonal relations: thoughts and suggestions” in: Tajfel, H. (Ed.) *The social dimension*. Cambridge Univ. Press.
- Reis, H.T. (1983):** “The Multidimensionality of Justice” in: Folger, R. (Ed.) *The sense of injustice: Social Psychological Perspectives*. Plenum: New York.
- Selten, R. and Ockenfels, A. (1998):** “An Experimental Solidarity Game”, *Journal of Economic Behavior & Organization* 34, 517-539.
- Walster, E.; G. Walster; E. Berscheid (1978):** “*Equity: Theory and Research*” Boston: Allyn & Bacon.

### Appendix: Consistent expectation without independent values.

Assume that the random variable  $\bar{x} = (\bar{x}_1, \dots, \bar{x}_n)$  is determined according to the joint distribution  $F(x)$  and that  $U_i$  is described by (3). Then  $i$  develops expectations  $E_i P_{ik}$  which depend on  $x_j = \bar{x}_j$ .  $j$ 's expectations of  $E_j P_{jk}$ , however, is constant. We will call

$$(31) EP_{ik} = E_j E_i P_{ik} = \int_x P_{ik}(U_{-i}) dF$$

consistent expectations. Again, in the system (33) all  $P_{ik}(U_{-i})$  are substituted by  $EP_{ik}$ : then, (33) provides us with a system of equation for  $EP_{ik}$ .

After the determination of  $EP_{ik}$  we are able to compute

$$(32) E_i P_{ik} = \int P_{ik}(U_{-i}) dF(x_{-i}, x_i = \bar{x}_i)$$

and

$$(33) U_i = \sum_k g_{ik}(x_i) E_i P_{ik}.$$