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A GAME THEORETICAL STUDY OF GENERALISED TRUST AND RECIPROCATION IN POLAND. I. THEORY AND EXPERIMENTAL DESIGN

Although studies using experimental game theory have been carried out in various countries, no such major study has occurred in Poland. The study described here aims to investigate generalised trust and reciprocation among Polish students. In the literature, these traits are seen to be positively correlated with economic growth. Poland is regarded as the most successful post-soviet bloc country in transforming to a market economy but the level of generalised trust compared to other post-communist countries is reported to be low. This study aims to see to what degree this reported level of generalised trust is visible amongst young Poles via experimental game theory, along with a questionnaire. The three games to be played have been described. Bayesian equilibria illustrating behaviour observed in previous studies have been derived for two of these games and the experimental procedure has been described.

Keywords: *experimental game theory, Bayesian equilibrium, trust, reciprocation*

1. Introduction

This study aims to investigate generalised trust and reciprocation among Polish students using experimental game theory. Many such studies have been carried out but, to the authors' knowledge, this will be the first major study in Poland [40]. The study plans to include 1600 students (100 in each of the 16 Polish regions). Due to the large scale of this project, to give a full description of the experiment, the theory in-

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volved and the results, the authors have decided to divide the material into chapters to appear as separate articles. As well as playing the games described here, participants will fill in a questionnaire on, among other things, their social interactions and attitude to inequality. A similar study was carried out in Russia by Gächter et al. [24], who studied a wider cross-section of society. One aim is to indicate how Poland's social capital might evolve in the future, as today's students are likely to be influential in the future. The questionnaire will be considered in a future article.

With this in mind, we have chosen three games: the Ultimatum Game [33], the Trust Game [7], and the Public Good Game [36]. As will be shown in this paper, behaviour in these games illustrates various aspects of reciprocity and the level of generalised trust in a society.

For the purposes of the paper, reciprocity is split into two classes:

- Positive reciprocity [6]. The positive response of a player to someone who is seen to have acted in a fair manner, even when that player incurs a cost to respond in such a manner and there is no prospect of future interaction between them. A person who exhibits positive reciprocity is called trustworthy.
- Negative reciprocity [20]. A negative response of a player to someone who is seen to have acted unfairly, even when that player incurs a cost to respond in such a manner and there is no prospect of future interaction.

It should be noted that the concept of reciprocity is intrinsically linked to the concept of fairness (or equity). This concept will be described more fully in Section 2.

An individual's level of generalised trust is understood to be the degree to which he expects those unknown to him to exhibit positive reciprocation or behaviour that is beneficial to a group as a whole, even at the risk of personal loss [48]. A simple measure of the level of generalised trust in a society is the proportion of people answering positively to the question: "Can people in general be trusted?" [28]. Experimental studies indicate that a positive answer to this question indicates that an individual is trustworthy rather than whether he/she is trusting [26]. However, using such an interpretation, answers to this question still indicate to what level individuals in a society can be trusted.

Generalised trust is seen as a component of social capital. Bourdieu and Wacquant [9] define social capital as *the sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalised relationships of mutual acquaintance and recognition*. Platje [44] differentiates between informal institutions (including a society's norms and culture) and formal institutions (including formal rules and methods of enforcement) which together form social capital. Formal institutions can change much faster than cultural norms, leading to institutional disequilibrium. However, informal social capital in the form of social networks can evolve faster than formal institutions. Platje [45] notes that such networks were used to solve problems related to inefficiencies in the planned economy. From Bourdieu and Wacquant's definition, social capital can be interpreted as the economic or social benefits resulting from formal and informal institutions. However, these benefits are difficult to measure. Hence, Growiec [28] considers social capital in terms of interpersonal networks, divided into bonding capital (close knit, family centred support networks) and bridging capital (looser networks, centred around friends and acquaintances). Growiec and Growiec [30] note that the level of bridging capital (measured by the frequency of encounters with acquaintances) is positively related to one's level of generalised trust. The relation of bonding capital to generalised trust is unclear, but EU countries with a high level of bonding capital and low level of bridging capital show a low level of generalised trust. Bonding capital can be a club good, excluding those outside the network. This can take pathological forms, e.g. the mafia [45]. Growiec and Growiec [27] note that bridging capital is positively correlated to earnings and subjective well-being. However, there is feedback between generalised trust, bridging capital, earnings and well-being. For example, those with generalised trust easily make new acquaintances, which aids in building up generalised trust.

Social capital is variously defined in the literature. The sociology literature tends to view it in terms of social networks with the level of generalised trust as an effect. The economics literature tends to define it in terms of social norms, generalised trust and public institutions (although Dasgupta [19] adopts the sociological approach).

Growiec [28] argues that exclusive family ties supress innovative behaviour (such as emigration). The relative strengths of bonding and bridging capital influence a student's decision on where to study. The level of internal migration in Poland is slowly increasing, but is low compared with Western Europe and likely to remain so in the near future [46]. Students are relatively mobile and likely to move to the most dynamic cities: Warsaw, Gdańsk, Poznań, Kraków and Wrocław, which are strong academic centres. Lewicka [41] gives an interesting viewpoint on the relationship between an individual's social capital and attitude to his/her place of residence. We will analyse the relation of students' behaviour with the strength of social ties to and the decision on where to study.

Arrow [5] and Putnam [48] see generalised trust as significant in making business and societies efficient. Platje [45] argues that high levels of generalised trust and reciprocation lead to low transaction costs, as less enforcement or punishment of opportunistic behaviour are required. Putnam argues that civic activity promotes trust, while hierarchical societies, trauma and authoritarian regimes suppress it. Algan and Cahuc [2] studied children of European emigrants to the USA. They note that children inherit attitudes from parents. Based on this, they assert that in the 20th century the level of generalised trust increased in Scandinavia, where successful social markets were constructed and there was little experience of war, but fell in Central and Eastern Europe, due to war and communism. The level of trust expressed by subjects is positively associated with economic growth in their parents' country of origin. Although feedback between economic growth and generalised trust exists, Knack and Keefer [38] argue that trust is more important in determining growth than vice versa, as trust is more strongly correlated with future GDP than current GDP. Their results show that trust is increasing in social homogeneity (in particular, with respect to ethnicity, religion and income). Also, they support Putnam's views on the negative relation between hierarchical religions and generalised trust (which is lower in Muslim and Catholic countries). Generalised trust is particularly important for growth in poor countries, which have less effective institutions to counteract opportunistic behaviour. Hence, countries can get trapped in a cycle of low income – low trust. These relations are illustrated by the behaviour predicted by the models of Zak and Knack [52] and Growiec and Growiec [29] describing investment and growth in an economy where one parameter is generalised trust. Kääriäinen and Lehtonen [37] note that in Europe the level of generalised trust in a country is positively associated with bridging capital and post-communist countries exhibit low levels of both generalised trust and bridging capital.

Growiec [28] interprets data from recent European social surveys from the point of view of Poland's social capital. She notes the country's low level of bridging capital and high level of authoritarianism. Hence, the very low level of generalised trust observed is expected, despite Poland's religious and ethnic homogeneity. However, Poland's economic growth since the transformation to a market economy, which began in 1989, seems remarkable. As Platje [45] notes, the initial fall in GDP was due to institutional disequilibrium. However, Poland was one of the first post-communist countries to grow economically and over the first ten years showed more growth than any other post-communist country (22%, Slovenia was in second place with 9%). In comparison, the GDP of the Czech Republic and Ukraine fell by 5% and 64%, respectively (source: European Bank for Reconstruction and Development, as quoted by Platje [45]). Ukraine, in particular, seems to have fallen into the low trust – low growth trap. Poland's economy has continued to grow in the 21st Century (although the growth rate fell after the 2008 crisis, Poland was one of the few European countries which did not go into recession). Czapiński [18] argues that Poland's economic growth stems from engaging its previously underutilised human capital and modernising the outdated production sector. Hence, growth is the result of investment in individual citizens and firms rather than in public institutions. However, the question remains as to whether the reported level of generalised trust in Poland is reflected in the behaviour of individuals in games designed to elicit the level of trust within a society. The studies carried out by Brosig-Koch et al. [10] and Ockenfels and Weimann [42] are of clear interest in this context, since they show that the level of co-operation observed in the public goods game continues to be lower in the former East Germany than in West Germany.

Section 2 presents the relevant concepts of game theory. In Sections 3 to 5 the games used are mathematically described and it is explained how the behaviour observed in these games relates to generalised trust and reciprocity. Section 6 describes the experimental design. In Section 7, we give a brief conclusion and description of future work to be done in this study.

2. General concepts and theory

For a general introduction to game theory, see Gibbons [25]. In the games considered here, each player makes one decision in a game played once with an unknown individual or individuals. For the purposes of this paper, we split the games considered here into two types:

- Games in which moves are made sequentially and the player making the present move knows all the moves that have been previously made.
- Games in which moves are made simultaneously in the sense that no player knows the decision made by any of the other players at the time he makes his move.

2.1. Games with sequential moves

We only consider games with two players. Player 1 chooses an action x_1 from the set S_1. Player 2 observes the action x_1 and chooses an action x_2 from the set $S_2(x_1)$. The payoff of Player *i* is denoted by $v_i(x_1, x_2)$. In this paper, the term payoff will refer strictly to the monetary payoff that a player receives from a game. All the payoffs given in the description of the games are the net payoffs which the participants receive in PLN. It is assumed that each player knows the strategies available to the other player and the payoff functions. The utility of Player *i* is denoted by $u_i(v_i, v_{-i})$, where v_i and v_{-i} are the monetary payoffs obtained by Player *i* and the other player, respectively. These functions are of the following form [23]:

$$u_i(v_i, v_{-i}) = \begin{cases} v_i - \alpha_i(v_i - v_{-i}), & v_i \ge v_{-i} \\ v_i - \beta_i(v_{-i} - v_i), & v_i < v_{-i} \end{cases} \tag{1}$$

where α_i and β_i are constants describing the discomfort Player *i* feels about inequality between payoffs when relatively well off and when relatively badly off, respectively. We assume that $\beta_i \ge 0$ and $\beta_i \ge \alpha_i$, since individuals should never feel pleasure, and feel greater discomfort, from inequality when they are relatively poor. Also, $\alpha_i \le 0.5$, since a player will not place more weight on another player's payoff than on his own. If $\alpha_i < 0$, then an individual is said to exhibit spiteful behaviour. We allow such a possibility as some studies indicate that players obtain utility by "winning" a game, i.e. getting a bigger monetary payoff than others, even at the cost of obtaining a small monetary payoff [16].

The economically rational solution is defined to be the Nash equilibrium when the utility of each player is defined to be the payoff he receives (i.e. in Eq. (1), $\alpha_i = \beta_i = 0$, $i = 1, 2$) and both players know that this is the case.

This function is simple, but we will show that by using it we obtain a good fit to much of the behaviour observed in previous studies. Andreoni [3], Andreoni and Miller [4] and Rabin [49] consider models where utility functions describe the players' levels of altruism. Fehr and Gächter [21, 22] observe that in a single-play game (i.e. players know that they will not interact in the future), players punish those seen to "act unfairly", even at a personal cost. From the point of view of classical game theory, this is irrational. Camerer and Thaler [13] argue that such behaviour results from learned norms, which is compatible with the use of individual utility functions, since players follow norms with varying strengths. This interpretation is important, as it highlights that players' behaviour results from their environment (formal and informal) rather than a rational analysis of the rules of a game. Kopczewski [39] notes that students who have studied game theory obtain lower payoffs on average in such games, as they are more likely to apply economic rationality rather than cultural norms.

Note that this utility function interprets an equal split of the payoffs as a reference point or "fair" solution. It will be argued that in the case of the standard ultimatum game, this is natural. However, as Güth et al. [34] show, when the equal split is unavailable in the ultimatum game, then observed behaviour can be radically different.

When each player knows the utility function of the other (i.e. each player has complete information), the Nash equilibrium can be derived recursively. Firstly, we find the optimal response $x_2^*(x_1)$ of Player 2 when Player 1 takes action x_1 for each $x_1 \in S_1$. By assuming that Player 2 makes this optimal response, the optimal action x_1^* of Player 1 can then be found.

In reality, players do not know others' preferences (utility function) but they may have beliefs about the distribution of preferences. In our context, players have prior distributions for the parameters used by others. Players maximise their expected utility given these beliefs. Since Player 2 observes the action of Player 1, he simply maximises his utility given this decision. Thus Player 2's beliefs about Player 1's preferences have no effect on the game. However, Player 2's optimal response depends on his utility function and Player 1 should maximise his expected utility with respect to his prior distributions for α_2 and β_2.

2.2. Games with simultaneous moves

Consider a game with n players. Player i chooses an action x_i from the set S_i. The vector of actions taken is denoted $\mathbf{x} = (x_1, x_2, \ldots, x_n)$. Player i's payoff is $v_i(\mathbf{x}) = v_i(x_i; \mathbf{x}^{-i})$, where $\mathbf{x}^{-i}$ denotes the vector of actions taken by all the other players. The function v_i is assumed to be twice differentiable. The game considered here is a four player game where players do not find out the actions or payoffs of the others, although they know the procedure for defining these payoffs. Hence, here we will only consider Nash equilibria in such games where players are economically rational and have complete information. However, it is assumed that, in practice, players' actions depend on their preferences. This will be discussed in Section 3.3.

At the Nash equilibrium, each player maximises his payoff given the actions of the other players. Hence, a necessary (but not sufficient) condition for the Nash equilibrium in the interior of $S_1 \times S_2 \times \cdots \times S_n$, denoted by $\mathbf{x}^*$, is given by

$$\frac{\partial v_i}{\partial x_i}_{|\mathbf{x}=\mathbf{x}^*} = 0, \quad \forall i, \quad 1 \le i \le n .$$

3. The ultimatum game

This is the game considered by Güth et al. [33]. A sum of 20 PLN (about €5) is to be split between two players. First, Player 1 (the proposer) states the amount x that he is to receive. It is assumed that x is an integer, i.e. $x \in \{0, 1, 2, \ldots, 20\}$. Player 2 (the respondent) observes this proposal and then decides whether to accept or reject it. If Player 2 accepts the proposal, then the payoff vector is $(x, 20 - x)$. If Player 2 rejects the proposal, then the payoff vector is (0, 0).

3.1. Economic rationality in the ultimatum game

Suppose that Player 1 proposes that the payoff vector should be $(x, 20 - x)$. When $x < 20$, Player 2 should accept the proposal, since he obtains a positive payoff rather than nothing. When $x = 20$, Player 2 is indifferent between accepting or rejecting. Hence, there are two pure equilibria. At one, Player 2 accepts any offer and Player 1 demands 20 PLN. At the other, Player 2 accepts a demand if and only if $x \le 19$ and Player 1 demands 19 PLN. There is also a mixed equilibrium where Player 2 accepts the demand of $x = 20$ with some probability and accepts all other demands. In this case, Player 1 randomises between demanding 19 PLN and demanding 20 PLN. Note that at each of these equilibria Player 1 demands nearly all of the funds available.

Behaviour in studies radically differs. Falk and Fischbacher [20] note that the respondent is commonly offered between 40 and 50% of the money. Such offers are hardly ever rejected. Almost no proposers offer more than 50%. Offers of below 20% are rare and often rejected. When respondents receive "random offers", their behaviour is similar to that predicted by classical theory, i.e. accept any positive offer. This suggests that respondents show negative reciprocation to unfair offers (by rejecting an offer, a respondent punishes the proposer at a cost to himself). Güth [32] states that players act according to learned norms. Camerer and Thaler [13] and Güth et al. [34] note that the precise definition of the game and its context are crucial in determining what is fair.

In the standard form of the game, the roles taken are chosen at random.

Thus we assume that an offer of 50% is seen as fair. This is confirmed by interviews described in Henrich [35]. Cameron [14] investigates the effect of the value of money to be split. The proportion offered to the respondent shows no significant change as this amount increases. However, the probability of accepting an offer of less than 20% increases (the absolute cost of punishment increases). The proposer could gain by demanding a large proportion of a large sum, but does not do so, possibly due to risk aversion [47]. Oosterbeck et al. [43] confirm these conclusions via a meta-analysis of studies. They note that in some studies the action of the responder is defined by a strategy of the form: "accept any offer of at least k", where k is a positive constant set before any offer is made. In such studies, rejection is more likely than under the standard formulation (used here), where the respondent obtains an offer before deciding whether to accept it. In game theoretical terms, these two formulations are identical. Roth et al. [50] analyse the results of experiments carried out in four cities. There are some subtle differences in behaviour. In Pittsburgh and Ljubljana, the modal offer was 50%, in Jerusalem it was 40%. Henrich [35] describes markedly different results from a study of the Machiguenga tribe. The proposer on average offered 20–25%, which was almost always accepted. There were a couple of proposers who had previous contact with Western culture and offered 50%. When interviewed, they stated that they offered 50% as it was fair but they were not afraid of a lower offer being rejected, as tribe members were always happy when given something. The author concludes that such behaviour results from cultural norms.

Due to these phenomena, behaviour is modelled using utility functions that take both absolute and relative payoffs into account. Using such a utility function, Bolton and Ockenfels [8] derive a Bayesian equilibrium. Costa-Gomes and Zauner [16] consider a similar model to the one considered here. However, their approach is statistical, rather than the probabilistic approach used below, since it is used to analyse the data obtained by Roth et al. [50].

3.2. Egalitarianism in the ultimatum game

Assume that the utility functions are of the form given by Eq. (1). Since, Player 1 generally proposes that he obtains at least half of the pool, we may assume that $v_1 \geq v_2$. Hence,

$$u_1(v_1, v_2) = v_1 - \alpha_1(v_1 - v_2) = (1 - \alpha_1)v_1 + \alpha_1 v_2$$

Analogously, the utility of Player 2 is given by $u_2(v_1, v_2) = v_2 - \beta_2(v_1 - v_2)$.

Suppose Player 1 demands *x*. Player 2 should accept this proposal if and only if $u_2(x, 20-x) > u_2(0,0)$. Setting $y = 20 - x$, this is satisfied if and only if

$$(1+\beta_2)y - \beta_2(20-y) > 0 \Rightarrow y > t(\beta_2) = \frac{20\beta_2}{1+2\beta_2}$$

Hence, Player 2 accepts any payoff greater than his threshold $t(\beta_2)$, which is increasing in β_2 and $\lim_{\beta_2 \to \infty} t(\beta_2) = 10$. Thus Player 2 should always accept a payoff of 10 (or greater). We can interpret β_2 as the readiness of Player 2 to punish an unfair action (i.e. negative reciprocation).

Now we derive the optimal action of Player 1 when Player 2 behaves optimally. When $\alpha_1 < 0.5$, if Player 2 accepts proposals x_1 and x_2, where $x_1 < x_2$, then Player 1 prefers x_2. Player 1 should thus offer the lowest share to Player 2 that would not refused. When $\alpha_1 = 0.5$, Player 1's utility is maximised when the proposal is accepted, i.e. an equal share should be proposed. We interpret such behaviour as "doing the right thing" (to be interpreted according to the context). Henrich [35] notes that some Americans immediately proposed equal shares and, when asked, stated that "this is fair", whereas some made the same offer only after some time. Such players may have considered demanding more, but wished to avoid a rejection, i.e. such a player has α_1 less than 0.5, but assumes that Player 2 is likely to have a large value of β_2.

In the following subsection, we relax the assumption of complete information (i.e. we assume that Player 1 does not know the utility function of Player 2).

3.3. Bayesian rationality in the ultimatum game

When choosing his action, Player 2 has no uncertainty regarding the behaviour of Player 1. As above, Player 2 rejects any proposal which gives him a payoff of less than $t(\beta_2)$.

If Player 1 has a prior distribution for β_2, the corresponding distribution for Player 2's threshold is easily derived, as it is a monotonic function of β_2. Hence, Player 1 can estimate the probability that the payoff vector $(x, 20-x)$ is accepted, denoted by $p(x)$. From the form of the threshold, $p(x)$ is non-increasing in x, $p(20) = 0$ and $p(x) = 1$ for any $x \le 10$. Player 1 maximises his expected utility, given by $\left((1-a_1)x + a_1(20-x)\right) p(x)$. We highlight the following two cases:

- $\alpha_1 = 0.5$. As described above, it seems reasonable to assume that such a proposer automatically offers an equal split.
- $\alpha_1 = 0$. In this case, Player 1 maximises his expected payoff.

3.4. Example

Suppose that 8 PLN are to be divided between two players and offers have to be a multiple of 1 PLN. The prior probability that the proposition is accepted is given by $p(x)$ in Table 1. The expected utility of Player 1 for various values of the parameter α_1 are given in the following rows. Here, the expected utility is given by

$$E[u_1; a_1] = E[u_1(V_1, V_2); a_1]$$

where

$$E[u_1;\ \alpha_1] = [(1 - \alpha_1)\, x + \alpha_1\, (8 - x)]\, p(x)$$

Table 1. The optimal proposal in the Ultimatum Game under Bayesian rationality

x	4	5	6	7	8
$p(x)$	1	0.9	0.7	0.3	0
$E[u_1; 0.35]$	**4**	3.87	3.22	1.47	0
$E[u_1; 0]$	4	**4.5**	4.2	2.1	0
$E[u_1; -0.35]$	4	5.13	**5.18**	2.73	0

The optimal utility of the proposer, according to the value of the parameter α_1 is highlighted in bold.
Source: the authors.

When the proposer maximises his expected payoff ($\alpha_1 = 0$), then he offers 3 PLN. When the proposer is altruistic ($\alpha_1 = 0.35$), then he proposes an even split. When the proposer is spiteful ($\alpha_1 = -0.35$), then he offers 2 PLN. Note that interpretation of the parameter α_1 is not straightforward. It was introduced as the degree of altruism. However, when payoffs are stochastic, we need to consider an individual's attitude to risk. When no other players are involved, an individual who always maximises his expected payoff is risk neutral. Those who prefer a certain payoff to a lottery with the same expected payoff are risk averse and those who prefer such a lottery are risk seeking [47]. Hence, what appears to be altruism, could be risk aversion or a mixture of risk aversion and altruism. Similarly, what appears to be spitefulness, could be risk seeking behaviour or combined spitefulness and risk seeking.

4. The trust game

This game is based on Berg et al. [7]. Player 1 is given 10 PLN. He can transfer an integer number x of PLN to Player 2. The value of the money he transfers will be multiplied by 3 (hence, Player 2 can receive up to 30 PLN). Player 2 then decides how much money y to transfer back to Player 1. Thus the payoffs resulting from the decisions x and y are given by

$$v_1(x, y) = 10 - x + y; \qquad v_2(x, y) = 3x - y$$

where $x \in \{0, 1, 2, \ldots, 10\}$, $y \in \{0, 1, 2, \ldots, 3x\}$.

The utility functions are of the form given in Eq. (1). As in the ultimatum game, an equal share in the payoffs is assumed to be fair using the argument that players' roles are chosen at random rather than by "merit". However, from the description of the game, there is no natural single reference payoff vector, such as (10, 10) in the ultimatum game.

4.1. The trust game with complete information

To simplify the analysis, x, y are assumed to be continuous variables. The qualitative form of an equilibrium is unaffected by this assumption. First, consider the action of Player 2. Assume that $\alpha_2 < 0.5$. When Player 2 has less money than Player 1, transferring money both decreases Player 2's payoff and increases inequality. Hence, no transfers should occur. When Player 2 has more money than Player 2, since Player 2 places more weight on his payoff than on Player 1's payoff, again he should not transfer any money.

Now consider the decision of Player 1. Since Player 2 will not transfer any money back to Player 1, arguing as above, Player 1 should not carry out a transfer that leads to Player 2 obtaining more than Player 1. When Player 1 transfers x, the payoff vector is $(10 - x, 3x)$. From the above assumption $10 - x \geq 3x$, i.e. $x \leq 2.5$. The utility of Player 1 is given by

$$u_1(10 - x, 3x) = 10(1 - \alpha_1) + (4\alpha_1 - 1)x \tag{2}$$

It follows that Player 1 should transfer 2.5 PLN when $\alpha_1 > 1/4$, otherwise no transfer is made. Hence, when Player 1 is relatively altruistic, he should transfer enough money to ensure equal payoffs. If both of the players are rational from the economic point of view, no transfers are made. Thus Player 1 obtains a payoff of 10 PLN and Player 2 obtains nothing.

Now assume that Player 2 does "the correct thing" (the case $\alpha_2 = 0.5$), understood to be equalising the payoffs of the players as far as possible. Suppose that when Player 2 makes his decision, he has no more money than Player 1. In this case, no transfer is made. Otherwise, Player 2 makes a transfer equalising the two payoffs. The payoff obtained by both players is thus $0.5\big((10-x)+3x\big)=5+x$, where $x > 2.5$. Hence, Player 1 should transfer 10 PLN, which is followed by Player 2 transferring 15 PLN back. Here, doing "the correct thing" is interpreted as Player 2 reciprocating positively. Note that this analysis assumes that Player 1 is not spiteful enough to prefer the payoff vector (10, 0) to the payoff vector (15, 15), i.e. $\alpha_1 \geq -0.5$.

As before, for the above analysis to hold, it suffices for Player 1 to know the type of Player 2 (whether he is a positive reciprocator or not). We have thus obtained three classes of solution that occur in different scenarios:

- When Player 2 is a reciprocator, Player 1 transfers the maximum possible amount and Player 2 transfers back half of the money he has. The payoff vector is (15, 15).
- When Player 2 is not a reciprocator but Player 1 is relatively altruistic, Player 1 makes a small transfer to Player 2 but receives nothing in return. The payoff vector is (7.5, 7.5).
- When Player 2 is not a reciprocator and Player 1 is not very altruistic, no transfers are made and the payoff vector is (10, 0).

4.2. The trust game with incomplete information – a Bayesian approach

Assume that Player 1 assigns a prior probability of p to Player 2 reciprocating and transfers x. When Player 2 is not a reciprocator, the payoff vector is $(10 - x, 3x)$. Now suppose Player 2 reciprocates. When $x \leq 2.5$, Player 2 does not transfer any money back and the payoff vector is $(10 - x, 3x)$. When $x > 2.5$, Player 2 transfers money to equalise the payoffs. From above, the payoff vector is $(5 + x, 5 + x)$. Consider cases where $\alpha_1 = \beta_1 > 0$ (which rules out spitefulness). Here, α_1 describes Player 1's level of egalitarianism. When $x \leq 2.5$, the payoff vector does not depend on whether Player 2 is a reciprocator or not. In this case, the utility of Player 1 is given by Eq. (2). When $x > 2.5$, his expected utility is given by

$$\begin{aligned} E\big(u_1(V_1,V_2)\big) &= (1-p)u_1(10-x,3x)+pu_1(5+x,5+x) \\ &= 10(1+\alpha_1)(1-p)+5p+x\big(p(2+4\alpha_1)-4\alpha_1-1\big) \end{aligned} \tag{3}$$

Since the expected utility is piecewise linear in x, one of the decisions $x = 0$, $x = 2.5$ or $x = 10$ must be optimal. From Eqs. (2) and (3), we should consider the four following cases:

- When $\alpha_1 \geq 1/4$ and $p \geq (1 + 4\alpha_1)/(2 + 4\alpha_1)$, Player 1's expected utility is non-decreasing in x for all $0 \leq x \leq 10$. In this case, the optimal strategy of Player 1 is to transfer all his money.

• When $\alpha_1 \leq 1/4$ and $p \leq (1 + 4\alpha_1)/(2 + 4\alpha_1)$, Player 1's expected utility is non-increasing in x for all $0 \leq x \leq 10$. In this case, the optimal strategy of Player 1 is to transfer no money.

• When $\alpha_1 > 1/4$ and $p < (1 + 4\alpha_1)/(2 + 4\alpha_1)$, the expected utility is increasing for $x < 2.5$ and decreasing for $x > 2.5$. Hence, the optimal strategy of Player 1 is to transfer 2.5 PLN.

• When $\alpha_1 < 1/4$ and $p > (1 + 4\alpha_1)/(2 + 4\alpha_1)$, the expected utility is decreasing for $x < 2.5$ and increasing for $x > 2.5$. When $x = 0$, Player 1's utility is $10(1 - \alpha_1)$. When $x = 10$, with probability p the payoff vector is (15, 15), otherwise it is (0, 30). Player 1's expected utility is $E\left(u_1(V_1, V_2)\right) = 15p - 30\alpha_1(1-p)$. It follows that Player 1 should transfer all his money if $15p - 30\alpha_1(1-p) \geq 10(1-\alpha_1) \Rightarrow p \geq 2/3$.

In qualitative terms, we can distinguish the three following cases:

• When Player 1 is confident that Player 2 will reciprocate (i.e. p is large), then Player 1 will transfer all his money.

• When Player 1 is sufficiently egalitarian ($\alpha_1 \geq 1/4$) but is not confident enough that Player 2 will reciprocate, then he will transfer some of his funds.

• When Player 1 is neither sufficiently egalitarian, nor confident that Player 2 will reciprocate, then he will not transfer any of his funds.

Hence, the behaviour of Player 1 depends on his levels of both trust and altruism (here interpreted as egalitarianism). This agrees with the observations of Cox [17]. Note that unlike the ultimatum game, altruistic behaviour corresponds to risk seeking behaviour, since Player 1 can guarantee himself a payoff of 10 PLN by not transferring any money.

Such behaviour by Player 1 is similar to that observed by Ashraf et al. [6], where there were high concentrations of transfers from Player 1 at the levels of 0, 50 and 100%. The first group are players with low levels of both altruism and trust. The middle group contains relatively altruistic individuals with low trust levels. The final group consists of players with a high level of trust. They used the strategy approach, i.e. Player 2 defined how much he would return for each of the possible transfers from Player 1. Using this approach, the level of reciprocation is lower than when Player 2 finds out how much has been transferred to him before making his decision [15]. This indicates that exhibiting trust might cause a psychological reaction eliciting positive reciprocation. Camerer [12] notes that in a range of studies, on average Player 1 transfers around 50% of his money and Player 2 returns 37% of the money received, i.e. on average Player 1 makes a slight profit.

Studies have shown that the amount transferred by Player 1 is associated with the expression of generalised trust, age and knowledge regarding the responder (see e.g. [1, 31, 51]). In our study, the players only know that the other players are also studying in the same city.

5. The public good game

Each of n players are given 20 PLN and decides how much money to put into a pool, without knowing the decisions of the others. The amount of money in the pool is multiplied by a factor k and split between the players equally. Here, $n = 4$ and $k = 1.6$. As in Sect. 4.1 assume that the amount a player pays into the pool is a continuous variable. It can be shown that the equilibrium is unchanged when these payments take an integer value.

Denote the amount of money that Player i places in the pool by x_i. Using the notation presented in Sect. 2, it follows that the payoff of Player i is given by $v_i(x_i; \mathbf{x}^{-i})$, where

$$v_i(x_i; \mathbf{x}^{-i}) = (20 - x_i) + 0.4\sum_{i=1}^{4} x_i$$

The first term is the amount of money a player does not place into the pool and the second term is the amount of money that an individual obtains from the pool.

For $i = 1, 2, 3, 4$, $\frac{\partial v_i}{\partial x_i} = -0.6$. Hence, given the decisions made by the others, Player i's payoff is decreasing in the amount he places in the pool. Hence, under economic rationality and complete information, $x_i = 0$ dominates any other action of Player i. It follows that at the only Nash equilibrium, players do not pay any money into the pool and each has a payoff of 20 PLN.

However, the sum of payoffs is maximised when each pays 20 PLN into the pool. In this case, each individual obtains 32 PLN. This game is similar to the Prisoner's Dilemma [25]. Hence, those who place a large amount in the pool are called "co-operators" and those who place a small amount in the pool – "defectors".

As explained in Sect. 2, we do not carry out an analysis using more general utility functions. Even for highly numerate students, it will be difficult to derive an economically rational decision. Hence, players' behaviour will be intuitive and reflect their level of generalised trust and altruism. In other words, it is expected that those with a high level of both generalised trust and altruism will pay the most into the pool.

Gächter et al. [24] carried out a study using the public goods game and questionnaire in various locations in Russia. The contributions to the pool were of a similar qualitative form to the transfers made by Player 1 in the Trust Game, i.e. concentrated on 0, 50 and 100% of the money given. Cadsby and Maynes [11] note that in a Canadian study using a slightly altered and repeated version of this game, females contributed more in the first round.

6. Experimental design

Since players should exhibit their natural behaviour, we do not want it to evolve according to the history of the games they play in, i.e. the players should play the games as three independent games with randomly chosen opponents. To do this, each regional group is split into subgroups A, and B and is given the appropriate instructions as follows:

- Those in subgroup A are assigned the role of Player 1 in the Ultimatum Game and Player 2 in the Trust Game. Those in subgroup B are assigned the role of Player 2 in the Ultimatum Game and Player 1 in the Trust Game.
- The material obtained by both subgroups first describes the Public Goods Game. They are told that the three other participants are chosen at random. The participants are asked to make their decision in this game but do not receive any information on their payoff or the choices of the other players.
- The material then obtained by those in subgroup A describes the Ultimatum Game. They are told that their proposition, together with a description of the game will be given to a random player. They are told to make their decision.
- Simultaneously, those in subgroup B receive material describing the Trust Game. They are told that a randomly chosen player will receive the transfer and a full description of the game. They are told to make their decision.
- The propositions of those in subgroup A are randomly assigned to those in subgroup B and the transfers of those in subgroup B are randomly assigned to those in subgroup A. All participants make their response in the appropriate game.
- The payoffs of the players are calculated and each participant obtains a monetary payoff equal to the sum of the payoffs obtained in the three games.

Each participant has a full description of a game when a decision is made. No additional information is available to anyone in the Public Goods Game or Player 1 in the other games, but the decision made by Player 1 is known to Player 2 (as required). In each case, the opponents are chosen randomly. Hence, it is reasonable to assume that participants treat these games as independent one-shot games with opponents chosen at random from the student population.

7. Conclusions and further work

Three games chosen to be used in a major study of generalised trust and reciprocation among Polish students have been described. A model for the preferences of individuals was used to define Bayesian equilibria in two of these games. The utility function used has two components: a player's monetary payoff and disutility resulting from inequality. Behaviour depends on several factors such as the level of generalised trust, altruism and attitude to risk. However, the effect of such factors varies in these games. The model gives a good qualitative description of the behaviour observed in the Ultimatum Game and of the behaviour of Player 1 in the Trust Game. However, it does not explain the phenomenon of intermediate levels of reciprocation by Player 2 in the Trust Game. Hence, this model should be developed using the data to be obtained from the study.

A subsequent article will consider the questionnaire to be used in the study.

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