"Free riding" as a consequence of an agent's adjustments to the publicly observed social involvement in the creation of the public good: the results of experimental research[1]

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Abstract: The paper describes the results of the experiments concerning sequential choices of economic agents, contributing to the creation of the public good. As based on the collected data, a model which explains the agents' decisions as a function of publicly revealed average social contribution was constructed. Previous experiments and practice have shown that the average contribution of agents falls in the subsequent periods, which is typically explained as a consequence of rising agents' frustration, resulting from the observation of the non-cooperative behaviour of other community members. The results described in this paper demonstrate that this is only partially true, as the increasing individual willingness to a free-ride is also observed in the situation when participants are misinformed about the growing level of the average social contribution. The paper concludes that an increasing tendency to free-ride is motivated by adjustments to average social contribution, as well as by the individual urge to maximize the short-term payoff.

Keywords: public goods, experiments, free-riding, sequential adjustments

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1. Introduction

The phenomenon of "free riding" occurs when agents using the public good avoid incurring costs of its creation[2]. There are a few alternative scientific theories[3] which explain decisions related to defining the amount of contributions to the public good. In the authors' view the existing theories are complementary as human behaviour in this case is quite complex – on one hand people are willing to cooperate socially, on the other they can analyse their preferences and pragmatically (egoistically) choose "free riding" as a solution increasing their own benefits. More or less since 50s of 20th century (parallel to development of the theory of games) economic experiments were implemented into analyses and solutions of economic problems. They consisted in observing people's choices controlled in laboratory conditions (see e.g. Krawczyk, 2012: 18-19). At present, these types of experiments (thanks to IT online solutions) have become a popular method of researching even complex economic phenomena (see Jakubowski and Kuśmierczyk, 2008a: 121-136). People's involvement in the creation of public goods is also examined by means of experiments (Kagel and Roth, 1995: 111-195). The paper presents results of such experiments carried out by the authors with regard to decisions about the amount of contributions to public purposes paid repetitively (when a particular good is used all the time and every now and then contributions have to be collected to cover the cost of its creation). The research results show that with sequential choices (in multi-rounds experiments) an average level of social involvement is initially relatively high, nevertheless it drops (see Kagel and Roth, 1995: 146-149) systematically in next analysed periods (rounds, repetitions), however misunderstanding of the issue was excluded as a cause to this drop. Psycho-sociological theories (see e.g. Andreoni, 1995) explain this phenomenon by people's strong tendency to cooperate which later on diminishes with frustration of observing the behaviour of "free riding". If it was true, then we should not observe a decreasing tendency to cooperate among participants of the experiment where the observed involvement tendency to create the public good was growing (not declining at least). The authors have decided to test this hypothesis by manipulating the information about the average contribution level achieved. As the result a model has been

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[2] Free rider's reasoning is based on the assumption that they cannot be excluded from the usage of the public good and that other people will contribute sufficiently to its creation.
[3] The authors discussed them in more detail in the work Jakubowski and Kusmierczyk, 2007: 163-184.

constructed allowing us to define in more detail the strength of a few basic factors (effects) affecting the observed changes to the tendency of "free riding".

2. Overall construction and assumptions of experiments

A typical experiment researching the problem of "free riding" is based on the game[4] where participants receive an amount of (real or virtual) money which they can use to pay contributions to the fund financing the creation of the public good. This good brings all participants equal benefits as the sum of collected contributions is most often doubled[5] and then divided between all players. For instance, if in a round each player received $ 10 and everybody assigned this sum to the public purpose, then each player would get $ 20 in this round – this solution maximizes the overall good as the "social income" obtained doubles. However there is a temptation to "free ride" – if a player keeps all the money to himself/herself (makes no contribution) and the others will pay in all the money (driven by the willingness to maximise the common good) then the money the "free rider" receives is tripled (with an appropriate big number of players and doubling contributions) as in the example to $ 30.

It is important in such experiments to provide players with a strong motivation to make rational, reckoned decisions (in order to best depict conditions for real economic choices). Participants of such experiments are usually financially rewarded proportionally to generated profits. A different solution not requiring big financial resources is to involve students who are rewarded with a special system of points raising grades from a particular subject (e.g. collected virtual money is calculated according to the algorithm into points which are then added to points gathered for being active at classes).

Let us emphasize that the tested hypothesis assumes that a change to human behaviour results mainly from observing decisions of other community members. People who think that they gave more on average than others should decrease their contributions in subsequent periods due to their frustration whereas people who gave less than others should not reduce the amount of their contributions (they are not disappointed with attitudes of the community) or even increase it

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[4] More details about the experiment may be found in: Jakubowski and Kuśmierczyk, 2008b: 101-116.
[5] Or multiplied by a number greater than one.

due to feeling of conformity. If those adjustments occurred both ways, the public contribution level could be enhanced through manipulation which entails informing that the social contribution level is higher and higher (higher than the actual one). According to the concept assuming that people want to cooperate with each other, firstly the social tendency to cooperate should not decrease, secondly it could even grow.

Table 1. Average contribution in subsequent rounds- group A manipulated with information about the contribution level.

Specification	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8
Contribution	1.21	0.78	0.68	0.64	0.51	0.57	0.50	0.35
Information	1.00	0.94	1.03	1.05	1.21	1.33	1.25	0.35
Change (%)	-	-35.5	-12.8	-5.9	-20.3	11.8	-12.3	-30.0

Source: Jakubowski and Kuśmierczyk, 2010.

The previous paper (Jakubowski and Kuśmierczyk, 2010) presented results of pilot experiments where students were motivated by money (each player was given 2 zł by the authors and was able to make a contribution). They were divided into groups – group A of 31 persons was manipulated with the information (see Table 1), whereas group B of 33 students was not manipulated [6] and students were provided with the actual average contribution levels (see Table 2). If the hypothesis was correct, in group B the average contribution should decrease whereas in group A it should maintain on the unchanged level at worst.

Table 2. Average contribution in subsequent rounds- group B not manipulated with information about the contribution level.

Specification	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7
Contribution	1.41	1.07	0.87	0.77	0.69	0.58	0.48
Information	1.00	1.07	0.87	0.77	0.69	0.58	0.48
Change (%)	-	-25.2	-18.7	-11.5	-10.4	-15.9	-17.2

Source: Jakubowski and Kuśmierczyk, 2010.

As we can see the tendency to "free ride" grew significantly in both groups (the willingness to cooperate diminished). The average pace of the contribution decline after excluding the first round (the starting level was different) and the last round (the fact that the

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[6] Except for the first, trial round when the level of 1 zł was announced to get the same level.

round was the last could influence the players) amounted 8.5% in group A, 14.2% in group B per round[7]. This difference is essential as it shows that "positive" information about the average contribution may have a certain influence on the behaviour of players – the decline in contributions in the group that was informed about overstated social contribution levels was slower[8]. For the purposes of a more detailed analysis of factors influencing the observed phenomenon a series of similar experiments are to be carried out and choices made by their participants will be described by means of a dynamic adjustment model.

3. Adjustment model – conclusions from estimations

Preliminary results of modelling participants' decisions (described above) were presented in the work of R.M. Jakubowski and P. Kuśmierczyk (2010). Initially a series of potential models was tested – the one below was characterised by the best adjustment:

$$X_{t+1} = (1 - \gamma) \cdot X_t + \alpha \cdot Y_t^+ + \beta \cdot Y_t^- . \text{ (1)}$$

In the above equation $Yt+$ variable shows how smaller the contribution of a particular person was as compared to the announced average. Variable $Yt–$ shows how greater this contribution was as compared to the information about the average pubic contribution. Namely:

$$Y_t^+ = \begin{cases} R_t - X_t, gdy\ R_t \geq X_t \\ 0, gdy\ R_t < X_t \end{cases}, \quad Y_t^- = \begin{cases} 0, gdy\ R_t \geq X_t \\ R_t - X_t, gdy\ R_t < X_t \end{cases} . \text{ (2)}$$

Where:

Xt- the amount of contribution of a particular person to the public fund in period t

Rt - the amount of announced average contribution achieved in the previous round.

In the above model α indicates the strength of "upward" adjustments when a particular person paid in less than the average for the entire group and may want to enhance cooperation to the average social level. B parameter illustrates the pace of "downward" adjustments i.e. when the

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[7] If we did not exclude the first round, the difference in the pace of decline would be greater as group B started at the higher average contribution level.

[8] It even grew in round 6 whereas in group B (not manipulated) it always declined.

contribution of a particular person was greater than the announced average for the group – this person will feel frustrated and will diminish their involvement in the creation of the common good. The last parameter may be called "the pace of learning rationality" i.e. lowering your contribution as compare to the previous period regardless of behaviour of others (because it pays off individually). The higher the value of each parameter, the greater importance of a particular adjustment whereas the value of α or β that equals 1 would mean that the person adjusts their contribution precisely to the level of the average contribution from the previous period.

For the purposes of estimation of model (1) laboratory experiments were carried out involving 122 students divided into 5 groups of 17-36 persons. Experiments were conducted by means of z-Tree (Fischbacher, 2007) online application. After logging onto, the student made a decision what amount out of zł 2 he/she wants to contribute to the public goal (the student kept the rest). Students were informed that the entire sum of money paid in by them is doubled and then divided between all of the equally. The student's profit in the first round t amounted:

$$Z_{i,t} = \left(2 - X_{i,t}\right) + \frac{2 \cdot S_t}{N} \text{ . (3)}$$

Where $X_{i,t}$ means the amount paid into the common pool by the student I in round t, N- the number of students, S_t- the total of all payments made by the students, namely:

$$S_t = \sum_{j=1}^{N} X_{j,t} \text{ . (4)}$$

As previously mentioned, the experiment makes use of information manipulation. Having collected all decisions and having familiarised with value S_t, the organizer of the experiment introduced a new value $S\sim_t$ and on that basis the profit per student was calculated for the particular round. At the end of the round the student was informed about the average (manipulated) contribution level and his or her profit. Then the next round started. The overall number of rounds was not revealed to students at the beginning in order to avoid a radical change of strategy in last rounds of the game. The organizer usually finished the experiment randomly about 20th round. In order to motivate students to make well-thought-out decisions a motivation

system was introduced where profits were calculated into points and added to credits or an exam[9].

Despite differences in the number of students in groups or the information revealed to them[10], the estimation of parameters in model (1) was made on the basis of collective data from all groups. Justification is twofold. Firstly, the estimation of parameters for each group separately would be based on a small sample and thus its credibility would be very much limited. Secondly, model (1) is a recursive model which assumes that a decision in a particular round depends on what was happening in the previous round – that is why it was possible to aggregate results from various groups. Also because of that reason all the data was analysed altogether regardless of which round they came from. Estimated values of parameters (on the basis of 2400 decisions) including test statistics[11] are included in Table 3.

Table 3. Parameters of the adjustments model.

Specification	α	β	y
Estimator's value	0.1124	0.6616	0.1830
Standard deviation	0.0104	0.0539	0.0161
Value ρ	9.75E-27	1.06E-33	0

Source: authors' own elaboration.

As we can see, all values of parameters are significantly different from 0. A general adjustment of the model measured by the determination coefficient is not too high and amounts to 0.608. Assumptions made in the stage of construction caused the model not to explain all reasons for a changing level of contributions. However, estimated values of parameters lead to conclusions. First of all, the carried out analyses have confirmed that the frustration factor (measured by means of parameter β influences most significantly the change to behaviour of players partially proving conclusions from the psychological research mentioned before. This factor plays a more important role than adjustments when then the particular player's level of

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[9] In order to have the most varied population the experiments involved students of different years, studying at Wrocław University of Economics and Opole School of Banking. The motivation system had to be adjusted properly. The number of additional points received by the student resulted from the average of his or her profits from all rounds.

[10] Researchers revealed various information about the level of contributions. In most cases the disclosed information was much higher than the real contribution but in one group they gave up the manipulation.

[11] *t*-Student was used to test the essence of estimated parameters

contributions is lower than the average. However there are "upward" adjustments (the value of coefficient α is significantly different from zero) but their importance is quite limited. In particular they are not able to reverse the trend of decreasing contributions. Even in groups informed about decreasing contributions greater than the actual ones, the extent of "free riding" systematically grew in each round. This leads to a suggestion that the hypothesis claiming that frustration resulting from contributions higher than others is the cause to the tendency to "free ride" is false. The surveyed participants contributed less and less with each round even when they were informed that the average contribution level was higher and higher! Upward adjustments measured by α parameter were only able to slow down the pace of declining contributions however they were unable to reverse the negative trend[12]. A significant value of y coefficient indicates that participants rationally lowered their contributions with each round as "free riding" paid off individually.

One of interesting hypotheses made in the presentation of the preliminary research (Jakubowski and Kuśmierczyk, 2010) was the hypothesis about a different reaction of women and men towards the information about the level of an average contribution. In particular the preliminary research suggested that the drop in contributions more significantly impacted women's frustration- in one of the groups women had a high parameter β with almost zero value of parameter γ. It was the other way round in case of men- the value of parameter β was close to zero with a relative high γ. This hypothesis was verified on the basis of discussed laboratory experiments in this paper.

Table 4 presents values of parameters estimated separately for women's decisions (N=1731) and men's decisions (N=728). The received estimation turned out approximate but did not confirm the hypotheses of the preliminary research.

Table 4. Parameters of the adjustments model for women (W) and men (M)

Value	α	β	γ
Estimator's value (W)	0.1048	0.6600	0.1835
Estimator's value (M)	0.1283	0.6707	0.1805

Source: Authors' own elaboration.

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[12] In groups where the information about the average contribution was overstated, the average pace of declining contributions amounted from 2.3% to 7.1% with each round. In the group informed about the actual contribution it dropped at the average pace of 8.9% with each round.

These results must be looked at cautiously. The specificity of the discussed research where the key thing was false information about overstated level of the average contribution led to rare situations when a contribution of a particular person was higher than the (announced) average[13]. If such a situation occurred, deviations from the average were minor (the revealed average was inflated). Participants did not have many opportunities to "frustrate" and this may be the cause to significant differences in values of parameter β[14]. However we have to restrain with refuting the hypothesis about differences in behaviour between women and men.

4. Conclusion

The research carried out shows that decreased involvement in the creation of the public good does not solely result from a decline in tendency to cooperate originating from the frustration triggered by observing others "free ride" although it is a significant factor. However an equally important factor is presented by simple benefits and costs calculation (and the choice of individual rational strategies).

The elaborated model explains the phenomenon quite well (significant value of parameters) but it does not comprise the complexity of the entire situation (R^2 slightly over 0.6). Further research should be directed at finding a model with better adjustment to the observed behaviour. Such a model could be helpful in constructing socially effective mechanisms coordinating public goods.

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[13] From an individual person's view.

[14] The hypothesis is merely confirmed by estimates of parameters for the group misinformed about the average payment. Very often the contributions of participants were lower than the average. Parameter β for the women in this group amounted 1.15 and for the men 0.697. Values of parameter γ were significantly different (compliant with the hypothesis made): _0.176 for the women (negative value!) and 0.346 for the men.

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„Jazda na gapę" jako rezultat dopasowani do obserwowanego społecznego zaangażowaniaw wytwarzanie dobra publicznego –wyniki badań eksperymentalnych

Streszczenie:

W artykule opisano wyniki eksperymentów, w których badano wybory podmiotów sekwencyjnie dokonujących składek na wytwarzanie dobra publicznego. Opierając się na uzyskanych danych, skonstruowano model opisujący decyzje takich podmiotów jako efekt reakcji na ogłaszany publicznie poziom przeciętnej, społecznej kontrybucji. Obserwacje życia gospodarczego oraz wyniki eksperymentów laboratoryjnych pokazują, że poziom wpłat na dobro publiczne obniża się w kolejnych okresach decyzyjnych. Jest to zazwyczaj tłumaczone rosnącą frustracją kontrybutorów, wynikającą z obserwacji niekooperacyjnych zachowań innych członków danej społeczności. Opisane w pracy wyniki doświadczeń laboratoryjnych, których istotą było manipulowanie informacją o przeciętnym poziomie społecznej kontrybucji, pokazują, że to twierdzenie jest tylko częściowo prawdziwe, ponieważ za obserwowany wzrost skłonności do „jazdy na gapę" odpowiada zarówno (opisana wyżej) frustracja, jak i racjonalna maksymalizacja własnych (krótkookresowych) korzyści.

Słowa kluczowe: dobra publiczne, badania eksperymentalne, problem „jazdy na gapę", sekwencyjny model dopasowań