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MODELLING AND IMPLEMENTING EMERALD GEM (GAME FOR ECONOMICAL MODELLING) FOR BEHAVIOR HYPOTHESIS CHECKING IN PUBLIC GOODS DISTRIBUTION

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Summary: This article describes one of the economic experiments for investigation of the free-rider problem. The problem is based on the desire to maximize individual profit by the avoidance of the participation in expenses.

Special network software was created for checking behavioral hypotheses in condition of the conflict between individual profit and public benefit.

At the beginning of this article you can find description of the experiment and its modifications. After that the main aspects of the software implementation of the experiment are described. Finally, some experimental results are presented. These results correspond with relevant results, described in literature.

Key words: economical experiment, free-rider problem, behavior of economic agents, hypotheses of a rational choice, cooperation effect, public benefit, network software.

Анотація: У даній статті описано один з економічних експериментів для дослідження так званої проблеми «безбілетника». Дана проблема проявляється у бажанні агента отримати максимальний прибуток шляхом ухилення від участі у витратах.

Для перевірки поведінкових гіпотез при конфлікті між індивідуальною вигодою і суспільним благом було створено спеціальне мережеве програмне забезпечення.

На початку роботи описується суть експерименту і його модифікації. Після чого представлені основні аспекти програмної реалізації експерименту. У заключній частині наводяться деякі результати проведених експериментів, які узгоджуються з теоретичними аспектами, описаними в літературі.

Ключові слова: економічний експеримент, проблема безбілетника, поведінка економічних агентів, гіпотези раціонального вибору, ефект співпраці, суспільна користь, мережеве програмне забезпечення.

Аннотация: В данной статье описан один из экономических экспериментов для исследования так называемой проблемы «безбилетника». Данная проблема проявляется в желании агента получить максимальную выгоду посредством уклонения от участия в затратах.

Для проверки поведенческих гипотез при конфликте между индивидуальной выгодой и общественным благом было создано специальное сетевое программное обеспечение.

В начале работы описывается суть эксперимента и его модификации. После чего представлены основные аспекты программной реализации эксперимента. В заключительной части приводятся некоторые результаты проведенных экспериментов, которые согласовываются с теоретическими аспектами, описанными в литературе.

Ключевые слова: экономический эксперимент, проблема безбилетника, поведение экономических агентов, гипотезы рационального выбора, эффект сотрудничества, общественная польза, сетевое программное обеспечение.

Laboratory experiments in economics have two main goals: first is to check initial axioms and hypotheses of economic theories and second is to accumulate data in order to formulate new assumptions and axioms. Basic axioms of economic

analysis are first of all behavioral prerequisites: assumptions about goals, motives, and reactions of people in the process of making economic decisions. It is hardly surprising that experimental economics integrates research devoted to people's behavior as it is exactly the basis of economic phenomena and processes both on micro and macro levels.

One of the basic areas of experimental economy is analysis of behavior properties which appear in cooperation. We can distinguish the public goods (the goods of the joint using which have a property of access exclusiveness for which there are effective decentralized maintenance mechanisms) and the public goods, i.e. the goods of the joint using, for which such mechanisms don't exist. This statement of the traditional theory of the public goods is deduced from assumptions concerning behavior of economic agents (hypotheses of a rational choice). The criterion of the maximum individual profit strongly stimulates the agent to avoid the participation in expenses while the property nonexclusive access grants him receiving of his goods. This effect, known as a free-rider problem, doesn't allow providing the public goods in optimum volume.

This paper is devoted exactly to modeling and software implementation of some laboratory experiment for checking behavioral hypotheses in condition of the conflict between individual profit and public benefit.

Motivation structure of individuals' behavior is based on the two main premises: existence of individual's interest in the results and influence of general rules on the behavior of one particular individual and other society participants' behavior (reciprocity hypothesis).

Software experiment is developed to confirm foreign results in the following main leads:

existence of behavioral inclination to the cooperation (reciprocity hypothesis checking);

influence of punishment on the behavior and the cooperation effect.

The experiment structure

Participants of the experiment (number of participants is $n > 1$) have the equal income $d > 0$ from which everyone independently allocates the contribution x_i, $0 \leq x_i \leq d$, to the total fund. The cumulative contribution of all participants is multiplied by the known coefficient $k > 1$, i.e. effect of cooperation (the public goods) is modeled. The received result is equally distributed between participants, i.e. participants will receive the identical income y_i from the total fund, independently from the contribution x_i:

$$y_i = \frac{k \sum_j x_j}{n} = k\bar{x}, \ 1 \leq i \leq n,$$ where $\bar{x}$ - the average contribution.

The final income of the participant as a result of cooperation will be equal to

$$z_i = d - x_i + y_i = d - x_i + k\bar{x}.$$

In case when $k > n$, the participant receives a profit from his nonzero contribution irrespective from actions of other participants that provides his strong motivation to participate in the fund, based on the individual interest.

Under a condition k <n the dependence of the income of the participant sharply amplifies from the behavior of others: he can receive both a profit, and loss. This condition provides the participants motivation to free-riders behavior because in this case they lose nothing, and can win only.

The experiment description

Various modifications of a base design of this experiment depending on research problems are known. We implemented the experiment with repetitions (rounds), and with the termination of game unknown to participants. Besides, the punishment (penalty) can be introduced in our experiment: participants acquire the right to fine each other, thus punishment can be not free for finer. For finding-out the influence of the factors connected with reputation, games with constant and variable structure of groups are spent. The structure of groups is known only to the experimenter, and doesn't change during game.
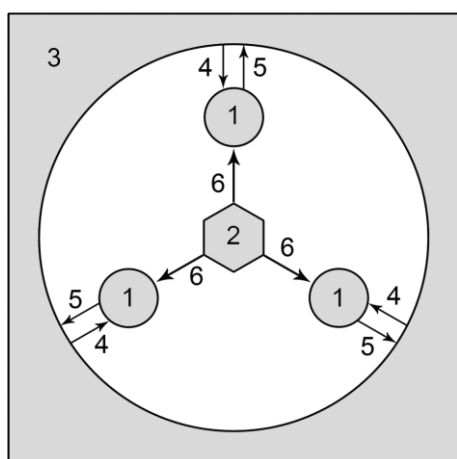
The gist of the experiment is as follows (fig. 1).

Fig. 1 The gist of the experiment.
3 - participant,
1 - profit source,
2 - total fund,
6- getting bonuses,
4, 5 - profit and investment payment.

The experiment is carried out with participation of one or several independent from each other groups containing N persons each and an experimenter. The experimenter sets up initial conditions: the number of rounds, the number of participants in each group, the profit for each participant at the beginning of the experiment, the multiplicative bonus coefficient, the multiplicative fine coefficient and whether the profit will be added at the beginning of each round and if yes then its amount. Besides the experimenter specifies whether the participant knows who fines him.

The game begins simultaneously after all participants authorize themselves. At the beginning of the game each participant gets some profit and knows the bonus and fine coefficients which he can get. At the beginning of each round each participant gets or does not get an additional profit (depending on the parameters of the experiment). In each round participants are suggested to make some investment into the total fund and everyone knows not only the amount of his own investment but those of all others. The total amount of investment is multiplied by the bonus coefficient and divided equally among all participants. After getting his bonus the participant has the right to fine his competitors (the chosen participant pays the fine calculated as pay for fine multiplied by the fine coefficient). Depending on the system options the participant either can see who fined him and how much or can see only the total amount of the fine. Funds that are fines and fine payments do not take part in the further game. If the participant was bankrupted, the experimenter chooses one of three variants: to exclude it from experiment, to finish the experiment or to give out the additional

income to all participants of experiment in order to make the balance of all participants positive.

Experiment ends when either all rounds end or experimenter decides so.

The experimenter controls the game so that he can see all activities in the system: the number of participants' profits and bonuses, their investments and fines. During the experiment all data are stored in the text file and in Excel format file for further processing.

After the experiment the participants fill in questionnaires to find out the relations between their behavior and personal characteristics (such as age, sex, education etc.).

Despite the fact that this topic is urgent, similar experiments which are carried out "by hand" are described in the literature. After

Fig. 3 Participant window.

searching on the Internet some software which can automate this process, only one program was found (z-Tree) that is developed in Zurich (http://www.iew.uzh.ch/ztree/index.php). However it has some imperfections: there is no Russian interface (Russian language is provided, but it doesn't work), therefore we have to work with the German interface; Help is absent (system has huge number of adjustments, but they aren't described); the program is free, but licensed that leads to difficulty of its obtaining..

Experiment implementation.

For carrying out of experiments the network software is developed. The cascade lifecycle model has been applied to its creation according to standard ISO/IEC 12207 [http://www.iso.org/iso/catalogue_detail.htm?csnumber=43447].

All stages of lifecycle have been implemented.

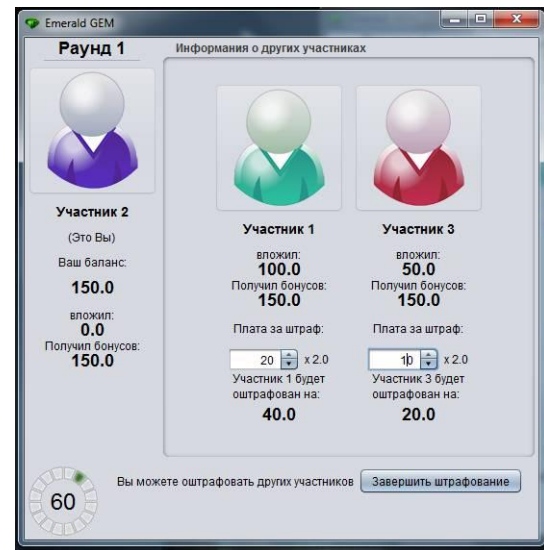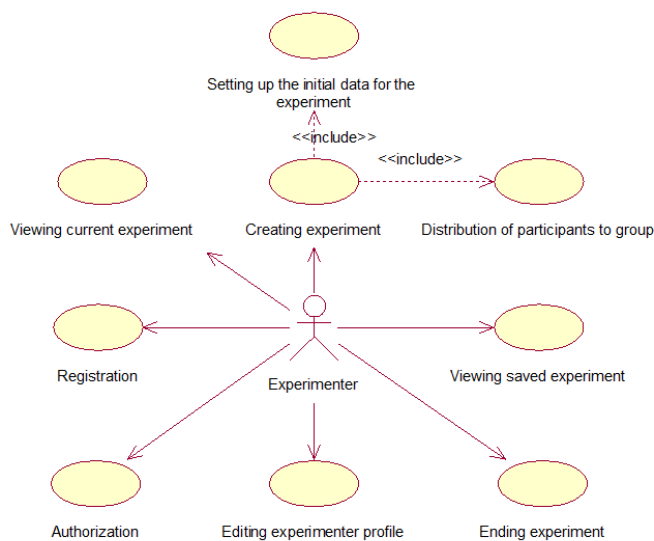On fig. 4, 5 Use-case diagrams of the experimenter and the participant are shown.

Рис. 5 Use-case of the experimenter.

On fig. 7. The class diagram of the developed model is presented.

The main class is class Experiment. It includes an array of objects of class Group and the link to the experimenter (class Experimentator). Each group consists of several participants (class Member). An array of results of each round of experiment (class Result) is stored in the participant. Result includes the data about the income of the participant in the beginning of the round, his investments, bonuses and fines.

The program is implemented on Java (Herbert Shildt SWING: A BEGINNER'S GUIDE. — M: "Williams", 2007. — With. 704. — ISBN 0-07-226314-8), the data is stored using SQL Server. To remove the necessity of setting up additional software, and also for transfer convenience of all database, the portable version of a SQL Server was used (SQLite, http://www.xerial.org/trac/Xerial/wiki/SQLiteJDBC). For network implementation TCP/IP protocol has been used.

All data about an experiment can be saved in Excel format for its subsequent handling (the library jxl.jar (http://jexcelapi.sourceforge.net/ is used for this purpose).

Results of experiment

Results of experiments carried out using the developed simulation model don't contradict with results which are described in the literature [2, 4, 6]:

1. People cooperate and punish each other in anonymous single-valued games where the future advantage from cooperation and effects of reputation are eliminated. It gives acknowledgement of a hypothesis of existence by strong reciprocity in behavior of people.

Рис. 6 Use-case of the participant.

2. The effect of fading cooperation in games with repetitions can be observed: in the beginning participants make high payments, but with magnification of repetitions cooperation "reserve" runs out – investments become substantially smaller. Cooperation slump can be explained by presence of people with different motivation in group: the behavior of "free riders" with their especially individualistic motivation exerts a disappointing influence on the participants inclined in cooperation.

3. Participants are inclined to punish those who make smaller investment. The given conclusion has been essentially extended by results of the researches carried out in the countries of the former USSR: the effect of "antisocial punishment" when people punish not only those who makes smaller investment, but also those who makes bigger one is observed.

4. Punishment increases and stabilizes the cooperation on higher level in comparison with experiments without punishment. It is confirmed with numerous experiments though there are also exceptions: punishment is ineffective, if it is
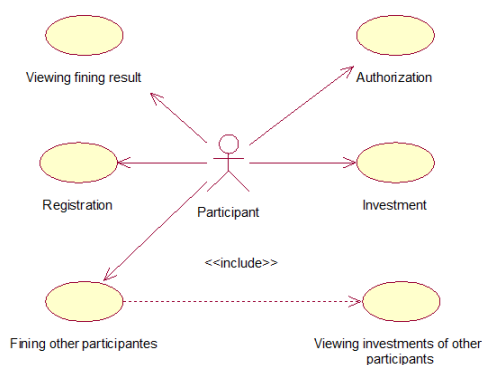
interpreted as the unfair. Experiments show that the exogenous (imputed) norms of punishment are less effective [8].

5. The strategic nature of interaction (the single game or with repetitions) has no essential value for punishment. People punish "free riders" both in repeated relations and in the single interactions. The punishment is often the most considerable in the last period of game that is incompatible with the model of egoistical rationality of the individual. Observations give the base to suppose that cooperation level is formed under the influence of strategic reasons whereas punishment is dictated by the impulse caused by the negative emotions, connected with partners «bad» behavior. It should be noted that punishment is normally used at weekly expressed cooperation which is typical for the beginning of the experiment, and it confirms its emotionality and short-sightedness [9].

For carrying out of the experiments that allow to research behavior of people from various social groups at the public goods allocation the model has been developed and the network software is implemented. Results of experiment are saved for the subsequent handling in Excel. Handling is carried out to check of hypotheses of various people behavior and their inclination to cooperation, and also influence of punishment on behavior and effect of cooperation.

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