Von Neumann-Morgernstern Modified Generalized Raiffa Solution and its Application

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Abstract In this paper we would like to discuss one of the possible modifications of Raiffa's unique point solution which has applications in the analysis of social networks associated with investing in social position and creating the structures based on mutual covering of violations of the generally accepted principles. These structures are formed on the base of games of Tragedy of commons type when one player detects breaking the rules by another player. Hence the first player begins bribing the other player and simultaneously covering his back, one player is rejudiced in favour of another player. This gives a rise to social networks that significantly affect the formation of coalitions in various areas of the social system, including institutions whose mission is to protect society against violations of the generally accepted principles. We also consider an original theoretical concept. We show that this concept can be used to implement the NM-modified Raiffa's solution for $n = 3$.

Keywords: three-person game, bribing, Nash bargaining problem; NM-modified Raiffa sequential solution; redistribution system; social networks based on mutual covering violate the generally accepted principles.

1. Introduction

Our approach comes from formal definition Nash bargaining problem for n players as a set B settled pairs (S, d), where S is compact convex subset R_n and point d belongs to S. The elements B of are called instance (examples) of the problem B, elements S are called variants or vector of utility, point d is called the point of disagreement, or status quo. Every example is called d-comprehensive. The theory suggests for the one-point solution several concepts. The term "solution" is understood as function f from B to R_n that each example (S, d) from B assigns value f(S, d) belonging to S. The most known concept of solution is Nash's one (Nash, 1950), the other is Kalai-Smorodinsky's one. The egalitarian approach suggested by Kalai (Kalai, 1977) can be also understood as the solution. All mentioned solutions can be expressed by axioms. Kalai-Smorodinsky's solution (Kalai and Smorodinsky, 1975) is maximum point on the segment S connecting point and so called utopian point , whose coordinates are defined as $U_i(S, d) = max\{x_i : x \in S \ a \ x \ \geq \ d\}$

From the point of view that we develop it is interesting Raiffa's solution that was proposed in the early 1950's. Raiffa (Raiffa, 1953) suggested dynamic procedures

for the cooperative bargaining in which the set S of possible alternatives is kept unchanged while the disagreement point d gradually changes. He considers two variants of such process – a discrete one and the continuous one. Discrete Raiffa's solution is the limit of so called dictated revenues. Diskin, A., Koppel, M., Samet D. (Diskin et al., 2011) have provided an axiomatization of a family of generalized Raiffa's discrete solutions.

2. Experimental Section

Let S is a nonempty, closed, convex, comprehensive, and positively bounded subset of R_n whose boundary points are Pareto optimal. They propose a solution concept which is composed of two solution functions. One solution function specifies an interim agreement and the other specifies the terminal agreement. Such a step-by-step solution concept can formally be defined as follows. The pair (f, g) functions is called step-by-step solution, if as $f(S, d)$ as $g(S, d)$ belongs to for each example (S, d) from B. The set of generalized Raiffa's solution is certain kind of step-by-step negotiation solution $\{(f_p, g_p)_{0<p<1}\}$ where are f_p a g_p defined as: $f_p(S, d) = d + p/n(U(S, d) - d)$, $g_p(S, d) = d^{\infty}(S, d)$,

where $d^{\infty}(S, d)$ is the limit of progression $\{d_k(S, d)\}$ of points constructed by induction follows: $d_0(S, d) = d, d_{k+1}(S, d) = f_p(S, d_k)$.

2.1. NM-modified Raiffa's solution

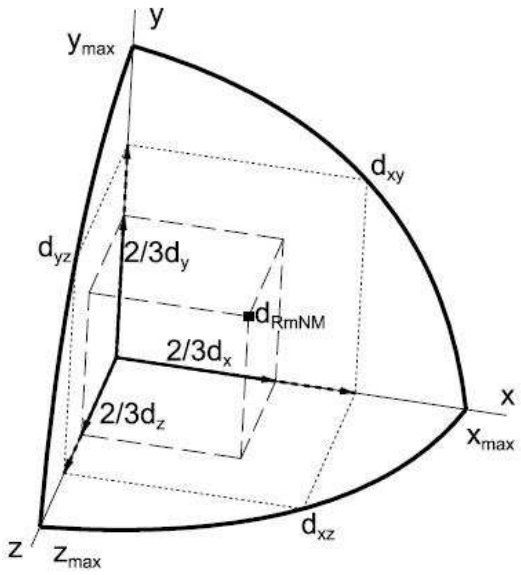
The solution that we suggest and that we called NM-minified discrete Raiffa's solution for n = 3 can be obtained by stipulating: $d_0(S, d)$, $d_{k+1}(S, d) = f_{nm}(S, d_k)$, where $f_{nm}(S, d) = d + 2/3(NM(S, d) - -d)$ where $NM(S, d)$ is point derived from utilities (in our interpretation we will use more suitable term pay-offs) of players in the points of Neumann-Morgenstern discrete internally and externally stable set on S. These points have coordinates: $d_{xy} = (d_1, d_2, 0), d_{xz} = (d_1, 0, d_3), d_{yz} = (0, d_2, d_3)$.

Note: from discrete solution which expect full symmetry of possibilities of players in the creation of two-person coalition exists also another NM sets having infinitive many elements. They play also important role, but we do not concerned with them. If we define $S = S(x_1, x_2, x_3)$, it means as the function of payoffs of players, then $d = (d_1, d_2, d_3)$ is given as the solution of following systems of equations: $S(x_1, x_2, 0) = 0; S(x_1, 0, x_3) = 0; S(0, x_2, x_3) = 0$.

Here it is valid that pay-off of every player in coalition with each other player (e.g. pay-off of first player with second player or with third player) is same. This fact causes the condition that points $(d_1, d_2, 0), (d_1, 0, d_3), (0, d_2, d_3)$ create discrete three-points NM set. The generalized Raiffa's solution and by us established NM-modified Raiffa's solution are very similar by their logic of construction.

Figure 1 depicts NM-modified Raiffa's solution d_{RmNM} for $n = 3$ graphically.

However, they have some important differences, especially from the point of view of interpretation. NM-modified Raiffa's solution d_{RmNM} in a certain way connects two situations: In the first case the players (each of them) decide to create only a two-person fully discriminated coalition, i.e. two players who form a coalition, can give to the third player the smallest possible pay-off. In our case this pay-off equals 0.



But the smallest possible pay-off can have also different value (including negative) what is important for some interpretations and with them connected application.

The simplest example is simple majority game described in Neumann and Morgenstern (Neumann and Morgenstern, 1953) and following game with coalition of different power (Neumann and Morgenstern, 1953), § 22. The same is valid in our case of the game with non-zero sum. In the second case the players form a great coalition, i.e. three-player coalition. The connection between both the cases can be interpreted as follows: Pay-offs of each player in the formation of fully discriminated coalitions can be seen from his perspective as an opportunity cost to the possibility of creating a great coalition. If players create a great coalition, for obvious reasons they will require pay-off higher or at least equal to the one they would have required in a two-person coalition. The problem is how to evaluate player's pay-offs for the creation of fully discriminated two-person coalitions.

2.2. Characterization of NM-modified Raiffa's solution

Here we use (introduced by us) the term average expected pay-off, which is a multiple of its pay-off in a situation where the player is the member of the winning coalition, and the probability of this coalition i.e. $2/3d_i$, where $i = 1, 2$ or 3. We simplify as we do not distinguish between pay-off and utility from pay-off. If the utility function of a player has degressive character, the risk aversion would play its role. The players would in such situation prefers two-person coalition even if the value of pay-offs is lower than $2/3d_i$. The value depends on the degressivity of utility function. But the example is not important for our future ideas. "Bridge" by which we're connecting both the cases (formation of two-player coalitions and the great coalitions above), i.e. application of the principle of opportunity cost and the introduction of the concept of expected average pay-off, implicitly contains input "step-by-step" process, which results in a single point solution in the case of great coalition.

The key importance of the presented concept consist in the fact that it enables us to express external factors that affect various real system, referred to as redistribution systems, in which the following applies:

- We have a group of people that operate within a certain system. They perform some role and, based on the performance of such role, they are attributed specific funds that are subsequently redistributed among them in a certain manner.
- Coalitions may be formed within the aforementioned group of people, with a view to provide privileges to those who take part in the coalition at the costs of those who do not.
- Such privileges are in the form of the funds the players may divide among them. Two questions arise in this connection: 1. What defines (how to describe) the amount of funds that the players would be able to divide among them; 2. How (based on what rules or regularities) will they divide such funds.
- In case social networks operate within the given system, we will understand them as one-sided or mutual affinity of certain players within the given system, whereas one and the same network may operate within a number of systems of this type. Generally speaking, a system will be referred to as a redistribution system if funds are divided and redistributed within the system as a result of certain external factors: Formation of coalitions within the given system; formation of social networks within the system; reflection of roles of such networks between different redistribution systems into individual redistribution systems. It is necessary to emphasize the fact that the aforementioned factors characterize, and not define, a redistribution system. The characteristics are used to give us an idea about the types of objects, to which it is possible to apply the tools developed by us.

A game, in which we do not consider any impact of external factors, shall be referred to as the original game for the sake of explicitness. External factors shall refer to anything that may be expressed by a change in the parameters of the original game, that affects the conduct of players, and that concurrently exists as

an independent parameter, the creation/development of which is not directly controlled by any of the players. The expression of the external factors through the change of the original game parameters shall be referred to as the original game extension.

3. Results and Discussion

3.1. Results and effects

Affinity of one player to another shall refer to the benefits (utility) the player gets just by forming a coalition with another player, whereas such benefits (utility) may be expressed in denominations that are used for payoffs within the original game. In case both players generate utility, it is referred to as mutual affinity; however, the extent may vary for each of the players. Positive affinity may also be referred to as sympathies of one player to another, with negative affinity being antipathy of one player to another.

Affinity may be expressed as follows: a player, who forms coalition with another player, generates specific benefits (utility) just by forming the coalition, whereas such utility are expressed in the same denominations as their payoffs. The total payoff of a player (referred to as $x_{ij}{}^{*}$) within a coalition with another player, under

a relationship of certain affinity, shall then equal to the player's payoff in the original game plus the player's payoff corresponding to the benefits (utility) arising from the formation of the coalition (the additional payoff shall be referred to as s_{ij}): ${x_{ij}}^* = x_i + s_{ij}$.

The value of s_i may be both positive (positive affinity – i.e. sympathies) or negative (negative affinity – i.e. antipathy). It would seem that if a one-sided or mutual affinity exists between two players, with no affinity existing between either of the players and a third player, the formation of coalition between the two players is predetermined. However, this may not be the case and if the third player is informed about the affinity of the other two, he may offset such positive affinity through a lower payoff. Let us assume that all players are fully informed about all affinities of the players. The original set of equations shall be modified as follows:

$$S({x_{12}}^*, {x_{21}}^*, 0) = s_{12} + s_{21}$$

$$S({x_{13}}^*, 0, {x_{31}}^*) = s_{13} + s_{31}$$

$$S(0, {x_{23}}^*, {x_{32}}^*) = s_{23} + s_{32}$$

Right-hand side of equations shall be interpreted by saying that additional payoffs arise within the game on the basis of the relevant affinities. The following shall then apply to the payoffs within the original game: $x_1 = 1/2({x_{12}}^* + s_{12} + {x_{13}}^* + s_{13})$, etc.

The original generalized Raiffa sequential solution does not allow the assessment of the role of affinities, because it does not contain an alternative to the formation of two-member coalitions with regard to the alternative of a three-member coalition formation, measured by opportunity costs. For the same reason, other point solutions of the Nash bargaining problem do not make it possible to assess the role of affinities. Therefore, we have created an original theoretical concept, on the basis of which we are able to identify (ascertain and assess) how external factors – in the form of affinities – affect any community or partnership of the redistribution system type.

In line with the specified objectives, the project solution is aimed at expressing (modeling, evaluating, and assessing) the impact of the following affinities and social networks interconnected by such affinities:

- Those that arise by investments in social status and are associated with a creation of social networks (affinities between players) derived from investments in social status.
- Those that arise by violations of principles generally accepted within the given system as well as its social environment and that lead to the creation of social networks relying on mutual covering, blackmail, and favoring of those entities that violate the generally accepted principles. We will mainly strive to describe the method of formation, development, operation, and anatomy of the structures based on mutual covering of violations of the generally accepted principles in terms of the potential elimination of their impact.

We will distinguish the following:

- Effects arising through investments in social status.

- Effects arising as a result of activities of social networks derived from investments in social status.
- Effects arising as a result of violations of the generally accepted principles.
- Effects arising as a result of activities of social networks based on mutual covering, blackmail, and favoring of players that violate the generally accepted principles, i.e. as a result of what we call the structures based on mutual covering of players that violate the generally accepted principles.

3.2. Effects arising through investments in social status

We all have a supply of investment opportunities. If we apply a rational decision making model, it is safe to assume that people will use investments funds available to them (both their own funds as well as funds raised on the capital market) to carry out such investment opportunities based on their respective rates of return. They will thus carry out those investment opportunities that offer higher rate of return compared to interest rate.

Now, let us assume that by investing in social status, it is possible to prevent the utilization of an investment opportunity by those, who cannot afford such investment. The effect of such situation will be an increase of the return from the investments in social status. Based on this, it is possible to draw three conclusions:

- An investment in social status has non-Pareto consequences for the bearers of investment opportunities (i.e. those, who cannot utilize funds into investments in social status, will be worse off).
- An investment in social status reduces social effectiveness (significant reduction of effects generated within the economic environment in case of the utilization of investment opportunities).
- An investment in social status will pay off to those, who make such investment, provided the effect of such investment as a result of higher share in the return of the given investment opportunity – as opposed to a situation, where the investment does not limit the utilized investment opportunities – exceeds the costs of the relevant investment in social status.

3.3. Effects arising as a result of activities of social networks derived from investments in social status

The scope of the primary effects is given by the difference between the expected average payoff, or between the payoff in the together acceptable equilibrium point (as appropriate), and the payoff the relevant player gets within the winning coalition. In order for a player to become (remain) a member of a winning coalition, he/she must make certain effort or act in a certain manner, as appropriate. It is then necessary to analyze, how the expected average payoff (payoff in the jointly acceptable equilibrium point) differs from the net payoff a player gets within the winning coalition (i.e. payoffs within the winning coalition minus all costs of a player associated with his/her participation in the winning coalition). In case it is possible to identify the costs of a player associated with his/her participation in the winning coalition, it is also possible to identify the ways of increasing such costs, through regulation or organization, thus at least partly eliminating investments in social status and their non-Pareto consequences.

3.4. Effects arising as a result of violations of the generally accepted principles

In this case, it is possible to derive from the game Tragedy of the Commons. In case there is a risk that a player might be detected and punished with a certain probability, it is possible to analyze under what conditions players opt to violate the principles. It is possible to use the existing literature - e.g. work of (Ostrom, 2008). However, existing analyses usually do not consider the role of the structures based on mutual covering of violations of the generally accepted principles. These analyses rely on the premise that a player, who decides to violate (or already directly violates) the generally acceptable principles, compares the benefits (utility) and costs associated with such violations, whereas the analyses that rely on the examination of such benefits and costs sometimes include proposals for reducing such benefits and increasing the costs. However, the analyses usually do not include, as one of the potential benefits, the fact that – by violating the generally accepted principles - a player wishes to take part in a structure based on such violations, because he/she derives benefits from the participation in such structure.

Furthermore, the analyses do not really consider the possibility that other players might actively seek out players, who wish to violate (or are already violating) the generally accepted principles in order to create a social network with them or to involve them in an existing network (also see the following section).

3.5. Effects arising as a result of activities of social networks based on mutual covering, blackmail, and favoring of players that violate the generally accepted principles, i.e. as a result of what we call the structures based on mutual covering

Let us first recall and further clarify the mechanism, on the basis of which the structures based on mutual covering of violations of the generally accepted principles come into existence. A player, who finds out that another player violates the generally accepted principles, has the following options:

- To spread the information about the violation of the generally accepted principles – i.e. to help to punish violating player.
- To overlook the conduct of the relevant player – i.e. no response.
- To start violating the generally accepted principles as well.
- To exploit the information – i.e. blackmail the relevant player. The higher sanctions are imposed for the violation of the generally accepted principles, the higher effect might result from the blackmailing of the player, who violated the generally accepted principles.

In case of an attempt to blackmail the player, who violated the generally accepted principles, the relevant player has several options:

- Refuse the blackmailing, even at the cost of being punished by the community.
- Notify the community of an attempted blackmail, which itself represents a certain form of violation of the generally accepted principles and, as such, may be sanctioned by the community
- Submit to the player, who is blackmailing him/her, and allow to be blackmailed. In this case, the blackmailed player compares the sanction to be imposed in case he/she does not accept the proposal of the blackmailer and the benefits generated if he/she accepts the blackmailer's proposal.

The higher sanctions are imposed for the violation of the generally accepted principles (in the form of uncooperative conduct in our case), the higher the protection of the community against such behavior, whereas the blackmailing of one player by another may prove to be more effective. As soon as the structures based on mutual covering of violations of the generally accepted principles start to form on the basis of this within the system, it may result in a significant reduction in the cooperative conduct and subsequent losses in effectiveness. In case this concerns a larger system, which creates its own institutional structure, it may result in serious dysfunctions of the entire institutional structure. More detailed analysis of these issues assumes the application and interpretation of other models, and this is the objective of the project solution. However, just the description specified herein shows that a community, which wishes to prevent the violation of the generally accepted principles that allow the development of such community (in general, principles of justice, fairness, and equality), must be able to detect the structures that wish to violate such principles. The given community's system of regulations must then be set up in a way that individual members of the community do not find it beneficial to form (become engaged in) the structures based on mutual covering of violations of the generally accepted principles. One of the project outputs will be the proposal of a structure (design) of such system of regulations, which would lead to the fact that the membership in the structures based on mutual covering of violations of the generally accepted principles would not be beneficial for players (community members).

It is already possible to describe the effects that arise on the basis of a player's involvement in a structure based on mutual covering of violations of the generally accepted principles. It is possible to distinguish several effects of this type. They are as follows: Effect of impunity, effect of predetermining coalitions, effect of favoring.

3.6. Effect of impunity

Let us first recall and further clarify the mechanism, on the basis of which the structures based on mutual covering of violations of the generally accepted principles come into Similarly as various communities create mechanisms and institutions that make it possible to detect and punish those players, who violate agreements or generally accepted principles, the structures based on mutual covering create various mechanisms and even institutions that allow effective covering of violations of the generally accepted principles. In case a player allows to be blackmailed, he/she gets under the protection of the relevant structure, which considerably or – to be precise – fundamentally reduces the risk that his/her conduct would be detected and punished by the community.

3.7. Effect of predetermining coalitions

Affinity between players given by an inclusion in the same structure based on mutual covering of violations of the generally accepted principles significantly predetermines the formation of coalitions. Players, who are not involved in such structures, virtually do not have a chance to compensate, through their concessions (reduction of the required payoff), the equalizing of chances for the participation in the winning coalition. Since the relevant affinities are covert by nature, they are not informed about them. Furthermore, this concerns very strong affinities, also associated with investments in social status.

3.8. Effect of favoring

We have not yet prepared a suitable model here. These are effects associated with principal-agent problems, when the structures based on mutual covering have the ability to appoint those, who are involved in such structures, to important positions in a organizations (for instance in a police structure to hinder or to stop police investigation of members such structure or in parliament in order to accept such bills that are convenient to the structures). There are two types of effects that arise in this manner: In the form of financial and nonfinancial returns from the prominent position within the given organization. In the form of significant expansion of the possibilities to violate the generally accepted principles with minimum risk of punishment. The above mentioned verbal description of effects gives the basic conceptual process for solution. From the methodological perspective, the solution will take place in the form of the application of the NM-modified Raiffa solution for the drafting models that allow the assessment of effects arising as a result of the activities of social networks based on mutual covering, blackmail, and favoring of players, who violate the generally accepted principles, i.e. of what we call the structures based on mutual covering. On the basis of such models, we will also look for answers to the following questions: What is the role of the players' knowledge of the existence of affinities? What possibilities has a player to compensate the impact of affinities if he/she is informed about such affinities? The elaboration of the relevant models within the project is associated with an analysis of real social situations – for example, events of indiscretion and absorption of indiscretion, as disclosed by public sources. From this perspective, the creation of theoretical models may play an important role in understanding the real social events.

4. Conclusions

1. A question arises, whether a three-player model is sufficient to describe events in the area of social reality. It is possible to consider two alternative extensions of the model. The first one consists in the creation of models for more players, which is associated with certain fundamental theoretical problems. The other one (which we believe to be more in line with the real life) is the possibility to examine, under what conditions a player line-up might change within a specific environment or, alternatively, what environmental change may result in the change of the player line-up and particularly the players' objectives. This is a problem area, which is taken into account by the project team; however, it is currently not the focal point of the project – so as not to make the project too ambitious, among other things. Therefore, when describing the effects arising as a result of the activities of the structures based on mutual covering, we will only confine to some of them.
2. From the perspective of the description of the proposed conceptual and methodological procedures, it is also necessary to mention another important aspect. The project solution assumes a wide range of theoretical outputs, from the application of the axiomatic approach, design of mathematical models on the basis of the game theory, to the creation of suitable concepts associated with the conceptual description of the social reality and analysis of real situations. On the one hand, this makes the project solution extremely challenging (and it may be rightfully pointed out whether the proposed team has sufficient qualifications); on the other hand, it offers the opportunity to demonstrate the possible appli-

cation of an exact theory in solving pressing social issues. The team expects to speak to certain leading experts and perform certain required theoretical outputs in cooperation with such experts in the course of the project.
This concerns, for example, the axiomatization of the NM-modified Raiffa solution. Using examples, it is possible to demonstrate that it is different from the generalized Raiffa solution and, therefore, should have a different system of axioms corresponding thereto. In case it is possible to explicitly express such differences, the results could be published in one of the leading international journals. However, it would particularly be of a considerable practical importance and demonstrate the possible interconnection of the theoretical (mathematical) bases of the game theory with the solution of pressing social issues, which are currently being discussed in the Czech Republic(corruption, ineffective public administration, operation of the system of political parties, etc.).

3. If it is possible to develop, without any serious problems, a suitable model for the effects of impunity and effect of predetermining coalitions, that would allow their assessment, it is more complicated for the effect of favoring.

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References

Becker, G. S., Stigler, G. J. (1974). *Law Enforcement, Malfeasance, and Compensation of Enforcers.* Journal of Legal Studies, **3(1)**, 1–18.

Benson, B. L., Baden, J. (1985). *The Political Economy of Governmental Corruption: The Logic of Underground Government.* Journal of Legal Studies, **14(2)**, 391–410.

Brousseau, E., Glachant, J.-M. (editors) (2008). *New Institutional Economics – a Guidebook.* Cambridge (USA): Cambridge University Press.

Colombatto, E. (2003). *Why is corruption tolerated?* Review of Austrian Economics, **16(4)**, 367–379.

David, T., Mach, A. (2007). *Institutions and Economic Growth: the Successful Experience of Switzerland.* In: CHANG, H.-J. (editor*). Institutional Change and Economic Development.* New York: United Nations University Press.

Diskin, A., Koppel, M., Samet, D. (2011). *Generalized Raiffa Solutions.* Games and Economic Behavior, **73**, 452–458.

Hardin, G. (1968). *The Tragedy of the Commons.* Science, **162(3859)**, 1243–1248.

Kalai, E. 1977. *Proportional Solutions of Bargaining Situations: Interpersonal Utility Comparisons.* Econometria, **45(7)**, 1623–1630.

Kalai, E., Smorodinsky, M. (1975). *Other Solutions to Nash's Bargaining Problem.* Econometrica, **43(3)**, 513–518.

Klitgaard, R. E. (1991). *Controlling Corruption.* Berkeley (CA) and Los Angeles (CA): University of California Press.

Lukašíková, M., Otáhal, T. (2012). *Vývoj vnímané korupce v zemích Visegrádské čtyřky a v Číně.* Scientia et Societas, **8(1)**, 36–47.

Menard, C., Shirley, M. (editors) (2008). *Handbook of New Institutional Economics.* Berlin: Springer.

Nash, J. F. (1950). *The Bargaining Problem. Econometrica*, **18(2)**, 155 – 162.

Neumann, J., Morgenstern, O. (1953). *Theory of Games and Economic Behavior*. Princeton University Press, Princeton.

North, D. C. (2003). *The Role of Institutions in Economic Development. UNECE Discussion Paper* Series, October 2003, No. 2.

North, D. C. (2005). *Understanding the Process of Economic Change.* Princeton (NJ): Princeton University Press.

Ostrom, E. (2008). *The Challenge of Common-Pool Resources.* Environment, **50(4)**, 8–20.

Ostrom, E., Andersson, K. P. (2008). *Decentralized Resource Regimes from a Polycentric Perspective.* Policy Science, **41**, 71–93.

Otáhal, T., Grochová, L., (2012). *Corruption, Rule of Law, and Economic Efficiency: Virginia vs.* Chicago Public Choice Theories. *ACTA VŠFS,* **6(2)**, 136–154.

Platje, J. (2008). *Institutional Capital as a Factor of Sustainable Development: the importance of an Institutional Equilibrium.* Baltic Journal on Sustainability. **14(2)**, 144–150.

Raiffa, H. (1953). *Arbitration Schemes for Generalized Two Person Games Contributions to the Theory of Games II.* In H. W. Kuhn and A. W. Trucker (eds). Princeton: Princeton Univeristy Press.

Trockel, W. (2009). *An Axiomatization of the Sequential Raiffa Solution.* Working Papper. Institute of Mathematical Economics (IMW), Bielefeld University.