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ANALYSIS OF INSTITUTIONS INTERACTION IN UKRAINIAN ECONOMY BY USING GAME THEORY MODELS

KEYWORDS: business, game theory, institutional theory, interaction, institutions, Nash equilibrium, Nash disequilibrium, oligarchy, society, Ukraine

ABSTRACT: This article is an attempt to analyse the functioning of the institutional environment through the prism of institutional interaction and cooperation between actors in the shadow and official economy. The authors suggest somewhat unusual mechanisms for understanding the most problematic current issues of interinstitutional cooperation in Ukraine. The investigation is based on current game theory, in particular an approach to interactions in the context of such models as “loyal business – opposition business”, “IMF – Ukraine”, “Ukrainian society – oligarchic groups”, which allow the sources, causes and consequences of the defacto functioning command system to be demonstrated. The research, which combined approaches to the innovative economy, the institutional economy and the theory of games is a good basis for explaining why a positive outcome, known as institutional cooperation, has not been achieved in the interaction between oligarchic groups and Ukrainian society as a result of a repetitive “game” for two decades. It is proposed to use Nash disequilibrium to disturb an ineffective economical system for receiving the effect similar to Josef Schumpeter’s creative destruction approach in entrepreneur role identification. In this way a synergy between game theory and innovation economics was implemented.

1. Introduction. Brief characteristic of the institutional environment functioning in Ukraine

One of the most fundamental facts regarding long-term economic development in the last century is the effectiveness of institutions and their interactions with society. If, at the end of the 20th century, scientists had just started to consider the importance of strengthening market institutions, then at the beginning of the 21st century institutional factors have a major role in explaining the success

of market transformations. According to O. Williamson, the institutional economy is a bridge to economic development, while institutions are a “hidden hand” in the economy’s management (Williamson, 2004).

The peculiarity of Ukraine’s development is the simultaneous evolution of market transformation and the establishment of statehood as well as the principles of democracy. Institutions that are the framework of competitiveness in developed countries are not sufficiently developed in Ukraine. Moreover, the Ukrainian state, with a centralized form of government, provides support mostly to those industry sectors that belong to oligarchic groups which form the elite authority at any particular time. State policy is manifested in regulating the macroeconomic situation, basically by using the depreciation of the national currency and therefore by exporting raw materials at a lower cost, while in developed countries attention is paid to economic growth through improvement of conditions for doing business, interactions between state authority, business and society, as well as industrial modernization as a key factor in competitiveness on the world market. Ukrainian citizens are trying to create and develop small and medium business for domestic demand and foreign economic activity, while the state’s measures do not simplify, but rather complicate, the business conditions and also increase the tax burden. Consequently, Ukraine has a high level of shadow economy while the investment climate is unfavourable.

The “«Taste of Life» As a Mechanism of Overcoming Corruption” (Hurnyak/Kordonska 2018), was an attempt to consider the degree of an individual’s satisfaction from living, functioning and carrying out their own activity in society in accordance with economic rules and regulations. To solve this problem, three approaches were applied by considering the “taste of life” as a function of state authorities’ services, shadow activity and communal budget. Based on statistical modelling and the results of expert surveys in 50 communities in the Ukrainian environment, the authors identified the degree of state regularities in society. The results indicate that the behaviour of those individuals who want everything to be taken over by the state and those who do not want to change anything (the shadow budget is approximately equal to the official budget in Ukraine) is similar, because the shadow sector works very effectively (from their point of view) and therefore the efficiency of the state and the community should be built through the effectiveness or inviolability of the shadow sector.

A. Tiffin stresses the importance of an effective institutional mechanism, noting that Ukraine has sufficient potential to be an economically developed country, since its labour force is relatively educated, the conditions for agriculture are among the most favourable in the world, and the infrastructure is also relatively developed (Tiffin 2006). Considering the ineffectiveness of the Ukrainian economy in contrast to other Central Eastern European countries, Tiffin mentions that institutions in Ukraine after the proclamation of independence have not been transformed

and, instead of moving towards a more market-oriented system, the institutional mechanism in Ukraine became a “vacuum”, and therefore this environment has been closed to innovation and production activities. He states that economic growth and quality of life development in Ukraine can be achieved by increasing efficiency rather than an accumulation of factors, which in turn depends on the authorities’ ability to create market-oriented institutions in order to implement reforms. He believes that Ukraine has a chance to become an “economic miracle” with an annual growth of 8.5% of GDP and a doubling of GDP per capita over ten years, in the case of correct implementation of institutional market-oriented reforms.

V. Filipchuk notes that the Ukrainian economic model is an example of closed institutions (Filipchuk 2013). From a historical point of view, Ukraine entered the 21st century with destructive, closed soviet political and economic institutions. In the 1990s Ukraine experienced only a “facade” transformation of institutions, while its western neighbours, Poland and the Baltic countries, started a period of European integration and institutional transformation to European models. The situation that took place in Ukraine in 2004, is described by V. Filipchuk as a classic example of what D. Acemoglu, S. Johnson and J. Robinson have mentioned: on the one hand, the victory of the reforming forces, on the other, their inability to create open institutions, which caused the creation of “a vicious circle of poverty” – the closeness of political institutions, the concentration of economic resources in the hands of a narrow circle of people, the economic decline of the majority of the population (Acemoglu/Johnson/Robinson 2002). Accordingly, we have a lack of incentives for economic activity, an increase in the shadow sector and emigration as a means of survival.

All these theoretical arguments presented above are confirmed by research by the Foundation for “Effective Governance”, according to which the low assessments of the Ukrainian business environment are caused by the following problems:

1. *Aggravating regulatory environment.* Complex bureaucratic procedures and excessive regulation create significant barriers to business activity. In a survey of business executives 61.1% of them mentioned the administrative regulation of business by the authorities (such as obtaining permits, creating the required reporting) as being extremely burdensome. On the one hand, cumbersome regulatory procedures, frequent rule changes and the order of their application significantly complicate business activity. On the other hand, a significant concentration of authority in the hands of officials contributes to corruption.

2. *“Bloated” and inefficient apparatus of state officials.* The current structure of the command system is not significantly different from that which worked in Soviet times. The remuneration, lack of motivation, corrupt hiring of employees, lack of an adequate system of evaluation of the efficiency of the officials’ work generally promote the importance of personal political ties.

3. *Opacity and low level of accountability.* The central and local authorities are not accountable to citizens. Feedback mechanisms, as well as effective citizen influence, which are important in maintaining the effectiveness of the system of deterrence and counterbalance, do not work.

2. Institutional interactions in Ukraine – game theory models

The main issue among scientists concerning the institutional system in Ukraine is why Ukraine, unlike most of its European neighbours, has not managed to go beyond the transformation period and move from institutions of the command system to institutions of a market economy. As a result of this imbalance, according to the estimations of the American Association of Accountants, the identification of the Ukrainian system is proposed to be described as a totalitarian or upgraded oligarchy.

In order to understand the functioning of the institutional system, we have to consider institutional interactions which are an illustrative framework for explaining sources, causes and consequences of the system functioning. In this context we want to propose an analysis of such *models* of society interactions as: 1) loyal business – opposition business; 2) International Monetary Fund¹ – Ukraine; 3) Ukrainian society – oligarchic groups.

3. Methodological basis

For such an analysis instruments of institutional economy would traditionally be used. At the same time, taking into account the absence of any significant influence of society on formal institutions and its clearly increasing distance from official institutions (by emigration, shadow economy, absence of actual mechanisms of influence etc.), we propose to use separate models of game theory²; game theory is not a traditional method for such investigation through research. An analysis of such models and the corresponding matrices of payoffs allows the reasons for non-fulfillment of a well-known “folk theorem”³ in Ukraine to be investigated,

¹ Hereafter: IMF.

² See also: D. McNulty, The Basics Of Game Theory. In: <https://goo.gl/AH2w8t> [Access 20.08.2017].

³ Folk theorems are used in Economics especially in the field of game theory and specifically to repeated games. This theorem is said to be satisfactorily fulfilled when the equilibrium outcome in a game that is repeated an infinity number of times is the same as the feasible and strongly individual rational outcome in the one-shot game. The outcome is said to be in equilibrium, because any attempt at trying to increase a player's individual outcome will imply a decrease in at least one other player's individual outcome. The origin of this theorem is unknown but it appeared in the late fifties, and became quickly

and why society till nowadays has been not unable to switch to mutually beneficial cooperation to be understood. Additionally, an analysis of the proper long term inequality in the case of non-rational actors should also be considered. It is proposed to create disturbance in the system with the aim to force this system by all available resources to overcome this disturbance, but in the direction of achieving cooperation.

The purpose and objectives of this research are to study the level of choice rationality in Ukrainian society based on models of institutional interactions. Using the results of the analysis an attempt will be made to argue the reasons for not fulfilling the *folk theorem* in the conditions of domestic society functioning or, conversely, to argue its actual execution. Moreover, we will try to solve this problem in case of irrationality.

4. Theoretical basis

The main theoretical base of the study is the research of R. Hall Varian presented in “Microeconomics”, which combines the tools and methods of game theory, institutional economics, mathematical analysis, innovation and behavioural economics (Varian 2010). Among other scientists, the issue of institutional interactions are analysed by J. W. Friedman, R. Gibbons, S. J. Grossman, O. D. Hart, C. Hurtado, J. H. Moore, J. E. Stiglitz. Among Ukrainian authors, we would like to highlight the recent work of Volodymyr Bilotkach (Bilotkach 2006).

The famous economist, US academic, and professor at the University of Chicago, Richard Thaler, who won the 2017 Nobel Prize for his work on behavioural economics should also be mentioned here. Nudge theory has been criticized by some sections of the political right for being overly paternalistic, while it has also been described as a neoliberal idea by the left because it relies on individual choice instead of overt state intervention. Unlike the field of classical economics – whereby decision-making is based on cold-headed logic – behavioral economics allows for irrational actions and attempts to understand why this might be the case. Thaler has provided a more realistic analysis of how people think and behave when making economic decisions. This relevant investigation is closely related to our attempts to understand institutional interactions.

known and spread within the game theory academia, and this is the reason why it became known as folk theorem. James W. Friedman in his article “A Non-cooperative Equilibrium for Supergames” (1971), was the first to write and publish a paper in which he thoroughly dealt with the theorem.

5. Game theory models and results of the study

5.1. Model 1: “loyal business – opposition business”

Let us suppose that we have two players: the [*Opposition Financial Group* (OFG)] and the [*Loyal Financial Group* (LFG) and the *Government* (we consider these together, since their common interest and mutual support are clearly observed)]. Among the possible tools for the opposition group, we distinguish: *consent to the sale and voluntary payment of debt* and *disagreement with the sale and refusal to pay debt*. Among the possible tools for the LFG are: *forced withdrawal and requirement for debt payment* and *purchase of shares and readiness to cover debt*. The maximum possible win in the matrix of payoffs will be accepted conditionally as 100 points. The loss of the enterprise and forced debt payment are separately estimated at 50 points. Transaction costs related to underreporting of the stock market, law enforcement and a judicial system which inhibits complete property elimination, even on the basis of a court decision, will be accepted respectively as 20 and 10 points. According to the above conditions the payoffs matrix in the case of a model of a competitive game of game theory will be as follows (table 1).

Table 1. The payoff matrix of the model “loyal business – opposition business”

		Opposite financial group	
		Sale and willingness to cover the debt	Refusal to sell and to cover the debt
Loyal financial group + government	Enforced confiscation and requirement for debt payment	50; - <u>50</u>	<u>90</u> ; - 90
	Acquisition of shares and readiness to cover the debt	<u>80</u> ; - 80	0; <u>0</u>

In the case of interaction in the upper left corner (50; -50) we have a situation of ongoing negotiations (or perhaps their imitation) with respect to the company’s fate and the availability of a debt decision. The lower right corner (0; 0) presents the situation without solution. According to the underlined points which represent the wins in this case, we can state that this model doesn’t demonstrate the balance of the Nash in the traditional sense.

In view of it, let’s try to use the mixed Nash equilibrium model. Let’s assume that “*p*” is the probability that LFG will choose a *policy of enforced confiscation and an unconditional demand for debt payment*. Let’s ignore the imitation possibility. Then independence from the decision of another player can be obtained from the equality:

$$(-50)*p + (-80)*(1 - p) = (-90)*p + 0*(1 - p) \quad (1)$$

Similarly, let's assume that "q" is the probability that the OFG will choose a *sales strategy and willingness to cover the debt*. Then the condition of independence of the choice can be shown as follow:

$$50*q + 90 * (1 - q) = 80*q + 0*(1- q) \quad (2)$$

The results of these probabilities ($p = 8/12$ and $q = 9/12$) indicate that the most acceptable solution for both sides is the combination of strategies in the upper left corner, when groups demonstrate mutual readiness to solution, but only partially fulfil their promises. This behaviour, obviously, is not rational and reflects potentially possible solutions of irrational players. Obviously, such a system has to be deduced from equilibrium.

Let's try to use a Nash disequilibrium point:

$$\beta_i = \min_{a_{-i} \in A_{-i}} \max_{a_i \in A_i} u_i(a_{-i}, a_i), \quad (3)$$

where A – joint action space of player; i , – level of utility of i player. In this case it can be mentioned a Schumpeter's⁴ theory of *creative destruction*, which can be used for the case of different society's game actors. We will try to assume the most influencing disruptive choice that system can to overcome (table 2).

Table 2. The payoff matrix of the model "loyal business – opposition business": Nash disequilibrium

		Opposite financial group	
		Sale and willingness to cover the debt	Refusal to sell and to Cover the debt
Loyal financial group + government	Enforced confiscation and requirement for debt payment	50; - 50	90; - 90* Quasi – formal decision
	Acquisition of shares and readiness to cover the debt	80; - 80 False cooperation	0; 0

Note: * – Refusal and compulsory withdrawal accompanied by the state authority inability to the adequate fulfilment of the formal rules

So, in this case (table 2) we demonstrate the destruction of ineffective system functioning with the aim to provoke using possible system resources to move in direction of collusion, but now on the base of rationality.

⁴ *Creative destruction* – a term coined by Joseph Schumpeter in "Capitalism, Socialism and Democracy" in 1942, describes the "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one". This occurs when innovation deconstructs long-standing arrangements and frees resources to be deployed elsewhere. Since Schumpeter, the term has been adopted into many other contexts outside of economic theory. See: Creative Destruction. In: <https://goo.gl/aaVnJ2> [Access 20.08.2017].

5.2. Model 2: “IMF – Ukraine”

For analysing the interaction between the IMF and Ukraine it will be used the “game of obligations” model. The basis of this model is the famous fable about the frog and scorpion⁵. We will assume the complete loss of the player as (–100) points and his full winnings as 100 points. Then, 20 points will show a decision making by “looking back” at the IMF’s response but “keeping in mind” the use of such a guaranteed opportunity; as well as show the desire to get credit despite anything, paying too much attention and resources to this transaction and simultaneously doing nothing in the field of effective usage of existing production factors (table 3).

Table 3. Payoff matrix of the model “IMF – Ukraine”

		IMF	
		Readiness to provide a loan	Refusal to provide a loan
Ukraine	Lending terms approval	–100; <u>50</u>	–20; 0
	Lending terms refusal	<u>80</u> ; <u>0</u>	<u>100</u> ; <u>0</u>

The Nash equilibrium is highlighted by underlined points in the matrix and can be reached by combination in the lower right and left corners. At the same time, it is clear that this decision in the model is rational but completely contrary to existing government practices in Ukraine. That’s why our next attempt is to provoke the system by achieving the Nash disequilibrium in the subgame (table 4).

Let we change for this case our condition for Nash disequilibrium:

$$\beta_i = \min_{a_i \in A_i} \max_{a_{-i} \in A_{-i}} u_i(a_i, a_{-i}). \quad (4)$$

The proposed disturbance step could be the next:

Table 4. Payoff matrix of the model “IMF – Ukraine”: Nash disequilibrium

		IMF	
		Readiness to provide a loan	Refusal to provide a loan
Ukraine	Approval of IMF lending terms	– <u>100*</u> ; <u>50</u>	–20; 0
	Refusal of lending terms	80; <u>0</u>	100; <u>0</u>

Note: * – a necessary condition for development is considered as refusal to stabilize the inefficient system.

⁵ Fable about the frog and scorpion (briefly). A frog and a scorpion are on the river bank and are looking for a variant of a joint or separate crossing to the other side. The scorpion offers a common cross to the frog: it will sit on the back of the frog and they will cross the river. Frog for a long time does not agree to such offer, fearing a scorpion bite. The last assures that he understands: the consequence of such step will be their common death. The arguments turned out to be quite persuasive for the frog. Somewhere in the middle of the river crossing, the scorpion stung the frog, arguing such an act of its “immutable nature”. Some researchers explain the fail of the “frog” by its misconceptions about potentially possible strategic “scorpion” decisions. See: The Scorpion and the Frog. In: <http://allaboutfrogs.org/stories/scorpion.html> [Access15.08.2017].

Consequently, in this case cooperation with IMF is a way of Nash disequilibrium aimed to provoke society to make the opposite choice.

5.3. Model 3: “Ukrainian society – oligarchic groups”

For illustration the interaction between oligarchic groups and Ukrainian society we will use the model of subordination, by other words “When the strength is weakness” (Varian 2010). The model of subordination is built on the basis of the relationship of animals, one of which by its characteristics should act as dominant in everything. At the same time, as it turned out in practice, in the situation of getting food, the dominant player made the efforts to get it, while the results of his work were used by the subordinated and weaker side. Considering Model 3, let’s assume the player’s maximum win or his maximum loss for 5 points. The only 1 point assessment for the oligarchic groups shows a consequence of the joint readiness of players to work on the basis of formal institutions of a market economy, while such groups are characterised by the lack of skills and habits, stable shadow schemes, behavioural heuristics, different value orientations and so on. An estimate of (– 4) in the lower right corner (table 5) is the result of the inevitable collapse of the system built on informal institutions, result of the failure in competition between the formal and informal sector in favour to informal⁶.

Table 5. The payoff matrix of the model “Ukrainian society – oligarchy”

		Ukrainian society (dominant player)	
		Willingness to pay taxes	Emigration, tools of the shadow economy
Oligarchy (subordinate player)	Promotion of market economy instruments	1; <u>4</u>	<u>0</u> ; 1
	Obstacles to the functioning of market economy instruments. Prevalence of informal decisions	<u>3</u> ; 1	–4; <u>2</u>

According to underlines in table 5, this model does not demonstrate the Nash equilibrium in the traditional sense. So, let’s use the model of the mixed equilibrium once again.

Let us assume p – as the probability of choosing by oligarchy the way of promoting the market economy tools, while q – as the probability of choosing

⁶ It should be emphasized, that for more accurate estimations of model results, it would be reasonable to demonstrate the *beta*-coefficients of linear regression models. But, in this case, we are interested not in the accuracy of numerical data but in comparative estimates. The correlation matrices constructed in this way confirm the approximate numerical estimates proposed in this article, and will be presented in subsequent articles.

by the Ukrainian society a *willingness to pay taxes*. Then we can demonstrate the equation of choice independence as follows:

$$1 \cdot q + (1-q) \cdot 0 = 3 \cdot q + (-4) \cdot (1-q) \quad (5)$$

$$4 \cdot p + 1 \cdot (1-p) = 1 \cdot p + 2 \cdot (1-p) \quad (6)$$

From these equations we get: $q = 2/3$; $p = 1/4$.

Thus, the optimal choice (Nash equilibrium) in this game will be the transition of oligarchic groups to the “obstacles to the functioning of market economy instruments” with a probability of 3/4 and the choice of Ukrainian society “willingness to pay taxes” of 2/3. The current situation in Ukrainian economy seems to be Mixed Nash Equilibrium. So again, as in previous analyses, we are faced with the problem of irrational choice.

Thus, let’s realize in this case the same approach of Nash disequilibrium (table 6):

Table 6. The payoff matrix of the model “Ukrainian society – oligarchy”: Nash disequilibrium

		Ukrainian society (dominant player)	
		Willingness to pay taxes	Emigration, tools of the shadow economy
Oligarchy (subordinate player)	Promotion of market economy instruments*	1; 4	0; 1
	Obstacles to the functioning of market economy instruments. Prevalence of informal decisions**	3; 1	-4; 2

Note: * – market rules promotion (from the side of actors that are not beneficial from them and will simulate changes);

** – informal rules promotion and no real opposition from society. Such a system will inevitably crash.

On this basis, we can talk about the special role of the shadow economy in Ukraine, which has no analogues in world practice.

Some researchers focus on more detailed models for analysing the possibilities of social development. Here should be mentioned in particular the *Rubinstein bargaining model* (Rubinstein 1982), which requires the presence of two players, their complete awareness, changeability of offers at each stage of the game and common time discount. However, this model in the absence of an agreement leads to the winnings’ elimination and is not appropriate in our analysis of institutional cooperation. At the same time, this is perhaps the only model of repetitive interaction that allows proposing the most acceptable offer from one player to another at the first stage of the game.

For illustration the approach called *folk theorem*, firstly proposed at the end of 60s of 20st century, we will use the simple matrix of payoffs “cooperation – violation of the agreement” (table 7).

Table 7. The payoff matrix of the model “cooperation – violation of the agreement”

	Cooperation	Violation of the agreement
Cooperation	3; 3	1; $\bar{5}$
Violation of the agreement	$\bar{5}$; 1	$\bar{2}$; $\bar{2}^*$

Notes: * – Nash equilibrium

The folk theorem argues that the equilibrium of repetitive interaction can be more successful for all players in their interaction than the equilibrium result of a one-stage game. Surely, such formulation is substantially simplified, but at the same time is sufficient for analysing the need of players’ rationality for its implementation. For proving this theorem, researchers determine a possible set of elections in the following way:

$$\{3; 3; \dots; 3; 3; 5; \{1; 2\}, \{1; 2\}, \dots, \{1; 2\}, 3; 3; \dots; 3; 3; \dots\}$$

The problem occurs when the reaction to the break of agreement leads to an endless set of solutions between 1 and 2, which obviously overrides all the previous solutions during the average utility calculation. Therefore, rational players in the repetitive game converge eventually into a “collusion” or “agreement”.

Now let’s imagine that the players are not rational and exists the difference between reality and the balance of the Nash equilibrium, like the results of our models proposed above. Accordingly, the duration of the transition between $\{1; 2\}$ and 3 may be delayed for an indefinite period of time, which still has happened in Ukraine. So, let’s try to demonstrate the Nash disequilibrium (disturbing step in the context of Schumpeterian entrepreneurship like in previous models) in case of *cooperation – violation of the agreement* model (table 8).

Table 8. The matrix “cooperation – violation”: Nash disequilibrium

	Cooperation	Violation of the agreement
Cooperation	$\bar{3}$; 3	1; 5
Violation of the agreement	$\bar{5}$; $\bar{1}^*$	2; $\bar{2}$

Notes: * – player’s choice is to disturb the system

By understanding the vulnerability and ineffectiveness of the system, we consciously choose to its imbalance the first step of the Schumpeterian approach, with the simultaneous understanding that huge resources of the system in this case will be directed towards the achievement of cooperation or conspiracy.

6. Conclusions

Consequently, it was made the attempt to combine approaches of the innovative economy, the institutional economy and the game theory for the analysis of Ukrainian society that is overwhelmed by the consequences of the command system. The results of interinstitutional research based on the payoff matrix of the interactions between “loyal business – opposition business”; “IMF – Ukraine”; “Ukrainian society – oligarchic groups” allow confirming irrationality of the players’ choice. With this in mind, the non-fulfilment of the *folk theorem* was analysed with taking into account the actors’ non-rationality in a potentially possible interactions and, therefore, their inability to effective equilibrium achievement was revealed. That’s why with the aim of system changing to market one it is proposed to stress it by using the mechanism of Nash disequilibrium combined with traditional Schumpeterian approach. The analysis results clearly demonstrate the need to change the system as a whole, since any of the individual reforms is absorbed by it and leads to the inaccessibility of general social cooperation.

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