

A Game Theory perspective on Public Institutions - the case of Romanian Education System

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ABSTRACT

Institutional reforms frequently fail because they are based on unrealistic hypotheses leading to limited models. A narrow mechanical vision focused only on hierarchy and roles may not be adequate when trying to understand how institutions work in the context of human society. Such a vision does not take into account human nature. We propose a model based on Game Theory and Behavioral Economics. Our model complements the centralized hierarchical vision about a public institution by adding a new dimension regarding the strategic interactions between agents/players. The case of Romanian Education System is considered as application domain. Three simple games describing common situations that appear inside this system are analyzed. Nash equilibria detected in these games indicate stable states of the system, states from which no player has any incentive to unilaterally deviate. The results help to explain why some reforms are so difficult to implement. Policy makers and institutional managers may find the proposed model useful in making public institutions more efficient.

KEYWORDS: *education, reform, Game Theory, Behavioral Economics, policy makers*

1. INTRODUCTION

Reform is a frequently used word when discussing about education in Romania. Several administrative reforms have been proposed in this field in the last 25 years. However, despite all these efforts, Romania is placed at the bottom of international education rankings (e.g. PISA tests and <http://thelearningcurve.pearson.com/index/index-comparison>). A natural question is why these reforms have been inefficient.

Reform failure raise some other questions: are the different actors involved in education (students, professors, administrators, and politicians) *really* interested to improve the system? Are they ready to pay the *required price*? Do we have a clear common understanding of the most important problems of the education system? Do we have a common set of values and/or goals? Do we have great educational leaders ready to follow?

In order to analyze a public institution like the education system we need an adequate model (without forgetting that, as George E.P.Box said, "essentially, all models are wrong, but some are useful"). When using a model some aspects are considered essential and others are neglected. What are the most relevant aspects about a public institution - in this case the education system?

A first model that comes to mind is a centralized model. According to this model the most important aspect of an institution/system is given by its hierarchical structure. Each role in the hierarchy is clearly defined. Each actor in the system knows what are his/her responsibilities and acts in accordance to his/her role. A set of policies is defined for each hierarchy level.

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A main hypothesis of this model is that each actor executes the commands arrived from a superior. The outputs produced by an actor may be measured using some performance metrics. In order to increase the system performances it is sufficient to change some policies/rules. This model is based on a mechanical vision about social institutions.

The previously presented centralized model is simple and clear. However, in our opinion, it does not appropriately describe the education system (since all models are wrong, the quality that we are looking for is usefulness). The main reason is the fact that such a system is composed in reality by complex human actors, not by machines executing programs. A human actor is never reducible to a simple role or function inside a mechanism. In a machine-based system it is possible to predict the results when changing a policy but in a social system this is not possible. How can such a model explain salient issues of the Romanian education system such as: abuse, corruption and lack of meritocracy?

Another problem is generated by a vicious effect of introducing quality metrics. Actors' behavior changes when a quality measure is introduced. As expected, in general, the actors are trying to maximize the measurable results by exaggerating the importance of the measured indicator even if their work quality actually decreases (i.e. publishing 4 low quality papers instead of a high quality one because the measured aspect is the *number* of publications).

This problem is generated by the difficulty to appropriately quantify the complex results of the education system. Measuring the output quality of a social system is a very difficult issue. If such a measure may be defined it will be a very complex one, which depends on the quality of the involved actors - an aspect hard to quantify since the actors are human. The mechanical model does not focus on the human aspects and therefore it fails to reveal some essential aspects. This may explain why the results of previous reforms were not as good as expected.

We consider that, in order to better describe the essential aspects of a public institution a different kind of model is necessary. This new model should take into account actor's autonomy and human nature - especially emotional/affective and psychosocial elements (values, motivation, identity, diversity, etc.). How different actors in the system make decisions is an essential aspect of the proposed model.

The aim of this research is to propose a new approach for analyzing the dynamics of a public institution, in particular the Romanian education system. Such a model may help policy makers and institution managers to achieve a better understanding about the system dynamics/behavior. Thus, they will be able to propose more efficient policies and to make better decisions for the common interest.

The next section presents the general principles of the proposed model that is based on Games Theory and Behavioral Economics. Section III presents some examples of games describing typical situations from the Romanian education system. Section IV concludes our paper.

2. A GAME THEORY BASED MODEL FOR THE EDUCATION SYSTEM

The proposed model does not make abstraction of the existence of a hierarchy and several roles in the education system. It only adds a complementary aspect that is considered essential: the actor *autonomy* and their *complex human nature*.

The vision of the proposed model is mainly inspired from Game Theory (GT) [1], [2], [3]. GT has been already extensively used in studying economic, biological, and social phenomena therefore it is also suitable for studying public institutions. Models/theories such as: Prisoner's Dilemma [4], Tragedy of the commons [5], Evolution of cooperation [6], [7], [8], Bounded

rationality [9] and Behavioral Economics [10] have been extensively used to describe social dynamics in classical and evolutionary approaches (see Evolutionary Game Theory [11]).

In GT, the Nash equilibrium is a key notion representing a state of the game where no player has an incentive to unilaterally deviate. Thus, a Nash equilibrium indicates a stable state, an attractor, and suggests a highly probable preference for a player. Nash equilibria may be detected using mathematical and/or computational tools (e.g. the "Gambit" software tool).

According to the proposed model, the actors of the education system are considered players in a game. Player interactions are strategic interactions: the benefit of one player depends on his/her actions but also on the actions of the other players. The system outcome is given by the collective actions of all involved players. An essential aspect is the player autonomy. A structure/order emerges from complex interactions and is not imposed from the top of hierarchy in a centralized manner.

A player aims to maximize a certain payoff that includes different aspects such as: financial, power, social image, self-esteem, identity, etc. The weight of each aspect is different for various actors. System dynamics and output are not deterministic. However, some statistical predictions are possible and numerical simulation may suggest the system behavior. Simplified situations are usually used to understand the model dynamics.

An actor/player may choose from a set of possible actions/strategies. The set of available actions is influenced by the role of each player and also by the player's personal capability to discover his/her options (which may also be different for different actors).

Actions discovery by a player goes beyond the classical Game Theory and requires a new generalized game model where player's actions are not known a priori. In this context it is highly important to understand how the actors/players are making decisions. The World Development Report 2015 "Mind, Society, and Behavior" [12] offers an insight about the mechanisms behind human decisions. According to this study several key aspects need to be taken into account when trying to understand human decisions:

- People are overwhelmed by information and it is impossible for them to accurately process all this information.
- In order to make efficient decisions people rely on a so called "automatic system" mainly based on heuristics and intuition. The most salient information is used with priority. However, people are also capable of deliberative thinking, which is much more costly in terms of cognitive resources and time [13].
- Most people are not aware about the multiple influences that guide their decisions. They consider themselves as deliberative thinkers but the reality is that the automatic thinking mechanism is prevalent.
- People's decisions are influenced by loss aversion [13].
- People usually respect social norms and expectations.
- People's preferences depend on the context (i.e. social context, poverty, etc.). Their decisions depend on their preferences.
- Many people appreciate fairness, reciprocity and prefer to cooperate. This observation contradicts the classical *homo economicus* model [14].
- The social group highly influences the person's behavior. The reverse is also true: a person may influence a group. Sometimes bad habits such as corruption are very resistant to change because the group accepts them - corruption becomes an informal social norm.
- Culture and education influences person's decision making through mental models (i.e. stereotypes, childhood education/stimulation, etc.).

Describing the entire education system as one unique global game is not a realistic task. Instead, some typical scenarios may be described as smaller games. The next section depicts several games played in the Romanian education system.

3. EXAMPLES OF EDUCATION SYSTEM GAMES

The games presented in this section help us to understand why the system is blocked in undesirable stable states and to estimate in which direction will probably evolve. Three simple games are described in this section.



2.1. The non-conformity game

Romanian education system, similar to other ex-communist countries, has a dark history that cannot be easily neglected. The communist past is responsible with the creation of a specific culture that comes with numerous undesirable mental and behavioral models. As expected, this culture was continued after the regime changed in 1989 since it was impossible to change it in a short period.

In this context, it is important to analyze what happens if one actor tries to change such a system. This actor will be called "non-conformist player". In order to analyze such a situation we propose a game called "the non-conformity game". The players involved in this game are: P1 - the university manager(s)/leader(s) and P2 - a non-conformist player (i.e. a professor) that tries to change the system. This situation is generated when the non-conformist professor proposes some new ideas while the establishment tries to keep the system stability.

This game represents an asymmetric version of the classical "chicken" game [15]. Each player has two strategies: "strong" - sustain its position and "weak" - give up/retract. If P2 chooses "strong" and P1 also chooses "strong" we have a "crash" situation where P2 is severely punished by an amount S (it may lose his/her job for instance - real examples are known) and P1 has a small loss (due to a possible negative publicity). If P2 chooses "weak" and P1 chooses "strong" P2 will have a small loss (at a psychological level) and P1 will have a moderate gain since its power was confirmed. If P2 chooses "strong" and P1 chooses "weak" P2 will have an important gain and P1 will have a moderate loss (in terms of power/image). If both players choose "weak" then P2 will have a small-medium loss (caused by regret and frustration) and P1 will have zero since its power is not challenged.

An instance of this game is depicted in Fig.1. Particular values are chosen for each payoff according to previously stated observations.

		strong		weak	
 P1 - Manager Payoff: 5.0000	strong	-2	-30	5	-8
	weak	-15	10	0	-3
 P2 - Non-conformist Payoff: -8.0000	strong	-2	-30	5	-8
	weak	-15	10	0	-3

Profiles	One equilibrium by logit tracing in strategic game			
#	1: strong	1: weak	2: strong	2: weak
1	1.0000	0.0000	0.0000	1.0000

Fig.1. The non-conformity game - normal form of the game and Nash equilibrium detected using "Gambit" tool. The values 1.0000 and 0.0000 related to the detected equilibrium represent the probability

to choose a certain strategy by a player. One pure Nash equilibrium is detected: P1 - "strong" and P2 - "weak".

A Nash equilibrium is detected for this game using the tool "Gambit". One pure Nash equilibrium is found: P1 - "strong" and P2 - "weak". P1 obtains a significantly higher payoff while P2 has a medium loss (frustration, low self-esteem). This result suggests that most non-conformist players will give up if they have an idea of changing the system that is not agreed by the manager(s). Thus, this game offers a possible explanation for the difficulty of changing a system using a bottom-up approach. Exceptions are possible since the payoffs have been selected based on very general assumption and also because humans are not purely "rational" (homo economicus). But statistically speaking there is a high probability for the non-conformist player to give up.

2.2. The revolt game

How the colleagues of the non-conformist actor will act? This question leads to another situation that may be also described by a game: "the revolt game".

This game is played by many actors but, for reasons of simplification, we consider only two players P1 and P2 that are both conformist colleagues of the non-conformist actor. Each actor/player has two strategies: "active" – sustain the non-conformist colleague and "passive" - take no action, ignore.

Several aspects should be taken into account for computing the payoffs for this game: the identity, the conformity, the default option and the loss aversion. If P1 plays "active" and P2 also plays "active" they form a team and they both have a significant gain (satisfaction of winning and being together as a group). Within the revolt game, if P1 plays "active" and P2 plays "passive" then P1 is let "in offside" and has an important loss (in terms of identity and also because one is not enough to win so the action fails) and P2 will have a small gain because it chooses the default option that it is also the safest (has a little satisfaction that he escaped the loss that arrived to the other player). A zero gain is obtained for all if both players choose "passive".

An instance of this game based on the previous considerations is described in Fig.2. Particular values are chosen for each payoff according to previously stated observations.

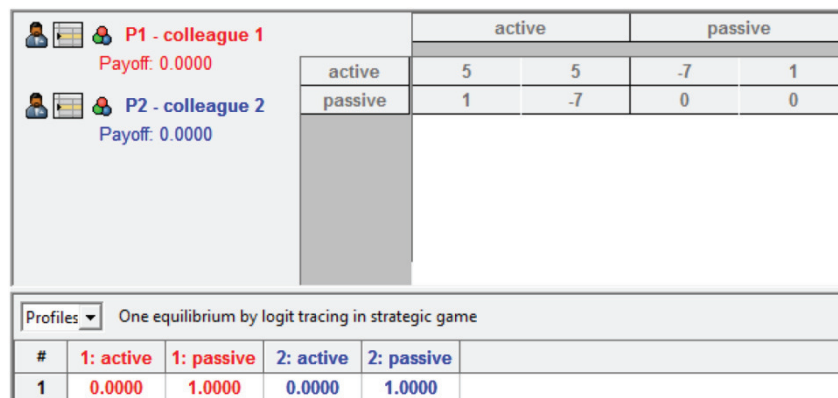


Fig.2. The revolt game - normal form of the game and Nash equilibrium detected using "Gambit" tool. The values 1.0000 and 0.0000 related to the detected equilibrium represent the probability to choose a certain strategy by a player. One pure Nash equilibrium is detected: P1 - "passive" and P2 - "passive".

One pure Nash equilibrium is detected for this instance of the game: P1 - "passive" and P2 - "passive". The players payoffs are zero in both cases. It may be noticed that this instance of the revolt game is equivalent to a classical Prisoner's Dilemma game [4] where both players have a higher payoff if they cooperate but each player prefers to defect because this is the "rational" selfish choice. This game also explains why changes against the establishment are so difficult: the players do not cooperate.

2.3. The quality loss game

Several years ago an education reform introduced an apparently logical principle: the government will finance a university *proportional with the number of students*. Each student involves a cost therefore universities with more students will get more money.

However, the global result for the society may not be as expected. This is due to the fact that, since the number of students is the most important aspect, the education quality, which imply significant costs, will be actually reduced in order to reduce the costs.

Why many students would choose a low quality university? Because they just want to obtain a diploma with a low effort. Why students cheat at exams or bribe a professor to obtain a desired grade? Because the grade is a very salient aspect, since the real learning is just a secondary goal that is sometimes completely neglected. In consequence, low quality universities with a large number of students get the maximum payoff. Additionally, there is practically no penalty for a university that delivers low quality education - a real feedback loop is missing in this case.

A similar situation appears at a smaller scale between professors and students. A game called "the quality loss game" is used to describe this kind of situation that applies particularly to some master studies where numerous students already have a full-time job and they have other priorities than the school. On the other hand, universities need a high number of master students to maximize their revenues.

Let us analyze a simplified situation: the players are: P1 – a professor and P2 - a student. Each player has two strategies: "low effort" - use a cost minimization strategy and "high effort" - use a quality maximization strategy. If P1 and P2 both play "high effort" they will both have a significant gain because they work together and they obtain results and satisfaction. If P1 and P2 both play "low effort" they will have a small gain because they save time and effort for other activities. If P1 plays "high effort" and P2 plays "low effort" the professor (P1) will have a medium loss because of the effort spent with low results and the student (P2) will have a small gain because he/she saves time and effort for other activities. If P1 plays "low effort" and P2 plays "high effort" the professor (P1) will have a small gain because he/she saves time and effort for other activities and the student (P2) will have a medium loss because he/she spent a lot of effort to learn in unfavorable conditions. This may be however compensated with a small-medium gain because he/she learned something despite the professor's attitude.

An instance of this game is described in Fig.3. Particular values are chosen for each payoff according to previously stated observations.



 P1 - Professor Payoff: 2.0000		high effort		low effort		
		high effort	5	5	-3	2
 P2 - Student Payoff: 2.0000		low effort	2	-1	2	2
Profiles ▾ One equilibrium by logit tracing in strategic game						
#	1: high effort	1: low effort	2: high effort	2: low effort		
1	0.0000	1.0000	0.0000	1.0000		

Fig.3. The quality loss game - normal form of the game and Nash equilibrium detected using "Gambit" tool. The values 1.0000 and 0.0000 related to the detected equilibrium represent the probability to choose a certain strategy by a player. One pure Nash equilibrium is detected: Professor - "low effort" and student - "low effort".

One pure Nash equilibrium is detected for this game: Professor - "low effort" and student - "low effort".

These results explain why the Romanian education quality goes down and reflect the real situation concerning the Master studies in Romania. Student needs to be attracted at any price, diplomas are delivered easily, quality goes down but nobody complains - at least nobody from inside. Obviously, exceptions exist but the major trend towards a lower quality is clearly revealed by this game and may also be observed in practice.

3. CONCLUSION

Game Theory and Behavior Economics offer an interesting insight for analyzing the complex dynamics of a social public institution. The Romanian education system has been considered as case study. An essential aspect of the proposed model is the tendency of the actors to choose those actions that maximize their utility and minimize their costs. Utility and costs are estimated starting from real statistical observations, scientifically documented, about human behavior.

Three simple scenarios are analyzed using game-based models: the non-conformity game, the revolt game and the quality loss game. The results obtained with the first two games confirm the fact that the status quo is very difficult to change for at least two reasons: it represents the implicit/default option and it corresponds to an equilibrium state, representing in this case an undesired but a stable state. Unfortunately, to act as a coward when having a different position than the establishment seems to be the rational and thus preferred choice for most actors. It is highly improbable to find brave actors that fight for their ideas against the conformist tendency of the majority and against their superiors. When such actors exist they are not sustained by their rational colleagues - and who can say that in the academic environment the people are not rational? If we add the fact that society perpetuates the culture and the mental models issued from the communist period the conclusion is a not very optimistic one. However, the reality indicates that brave leaders always existed and, at some critical point, they may produce a significant change.

The third game explains why the education quality is decreasing when universities are financed based on the number of students and no penalty exists for low quality education. If nothing changes about this situation the expected result will be an even lower quality of the education.

The proposed approach complements the classical centralized model that does not put in evidence actor's autonomy and human nature. The proposed model may be applied on any public institution. Typical situations may be formalized as simple games. Managers and policy makers may use such a model in order to create better policies for society. To follow a mechanism design, also called reversed game theory approach, for reforming social public institutions seems to be a promising research direction that deserves further investigation.

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