Design of the Economic Mechanism of Sustainable Development of the Socio-economic System of the Region

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Abstract: The significance of the influence of exogenous factors on the stability of the state of the socio-economic system (SES) necessitates the development of a methodological framework for regulating regional systems. One of the most important criteria for assessing the sustainability of SES is the state of human capital, which presupposes, first of all, the sufficiency of medical services in accordance with the necessary dynamics of natural reproduction of labour resources. The results of the research presented in the article summarize the author's ideas in the possibility of modelling the choice of an economic mechanism for financing the regional health care subsystem that provides the required level of sustainability based on the adequacy of financing of medical services. The basic theory of formalization of the problem of the design of the economic mechanism was the mathematical theory of games. The model for choosing the economic mechanism of the regional health care subsystem is formulated in terms of the design problem for economic mechanism.

1 INTRODUCTION

Studies of theoretical provisions that determine the content of economic mechanisms (Burkov et al., 2008) revealed the ambiguity of ideas about the current economic mechanism for managing the territorial health care system, as a condition and factor of a stable state of the socio-economic system (SES) of the region. S.A. Livshits emphasizes that an effective economic financing mechanism is "an important task facing health care in modern socio-economic conditions, and providing health care with the necessary economic resources is a complex problem that can be solved within the framework of economic regulation "(Livshits, 2003).

The main problem of the effectiveness of such mechanisms is, from our point of view, discrepancies in the formation of the model itself, namely, the existence of different approaches to the definition of the concept of "economic mechanism". In most studies, as a basic approach to the content and structure of the economic mechanism, the view of A.

Kulman (Kulman, 1993) is taken. Akindinova N.V. et al. (Akindinova, 2018) note the identification at the international level of a positive relationship in the long term between the level of health care spending and key indicators of national health (infant mortality, life expectancy), first of all, a direct relationship was established between the level of funding for the industry and mortality. Considering that many factors influence life expectancy, this indicator, as shown in the studies of M.A. Rizvanova, most sensitively reacts to the growth of health care costs in less developed countries (Rizvanova, 2006).

2 RESEARCH METHODOLOGY

From the standpoint of theoretical studies, stability is considered as a fundamental property of the system, considering stability as a fundamental property of systems, allows us to assess the priority of stability factors from the position of the structure of the system.

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Thus, the study of the sustainability of the development of the socio-economic system (SES) of the region implies that in its structure it is possible to distinguish subsystems that affect the state of sustainability, namely: society, material and technical complex and natural resources, while it is assumed that the sustainability of development should be characteristic of each of them. The special place of society is not only because the ability of residents of the territory to maintain life well-being and social stability is the goal of the development of the system, but also because society is a decisive element in the development of productive forces.

Assessing the sustainability of the socio-economic development of the region as opposed to its crisis state, it is necessary to pay attention to two circumstances:

- the ability to function as a self-developing system is the most important functional characteristic of the region (Gutman, 2002);
- in the list of indicators of sustainable development of the territory, which determine the main forms of security - social, economic, environmental, a special place is occupied by health care as a subsystem playing a leading role in maintaining the state of society.

For many years, health care in the studies of Soviet and Russian scientists was defined as a branch of the non-production sphere, which is characterized by the spending of budgetary funds, without participation in the formation of the national product.

A preliminary assessment of the results of the implementation of specific economic mechanisms that ensure the solution of urgent problems of preserving the health of the population showed the nature of their impact on the state of sustainability of the SES in the region.

Leading experts in the field of healthcare have repeatedly considered the need for a more dynamic change in the financing system (Panurin and Khan, 2017; Martynova, 2019; Pyatakovich et al., 2004; Rizvanova, 2006). The formulated requirements for the content of measures to improve the effectiveness of health care financing also include the need to change the funding mechanism, taking into account the strategic goal of increasing the level of motivation of participants.

The measures presented to address the challenge of changing the funding mechanism in accordance with the recommendations should include:

- strengthening the reasonableness of the allocation of funds allocated to health care;
- greater transparency in the use of financial resources;

- development of competition between medical organizations in the compulsory health insurance fund (CIHF) system (where possible);
- widespread introduction of new ways to pay for medical care in the CIHF.

At the same time, an analysis of the practice of financing the health care system in the region, carried out on the example of the Irkutsk region, showed that financing of health care is carried out at different levels of management with the implementation of signs of several economic mechanisms. However, the main, from the point of view of implementation efficiency, is the approach to the design of the economic mechanism as a tool for managing facilities (Kulman, 1993), which is implemented within the framework of the State Program "Healthcare Development" (State program «Development of health care», 2017). Such a mechanism assumes:

1. Coordination of resources, providing an effective solution to the problems of managing the economic system. In almost every health care system, there is inevitably a combination of public and private funding, however, the issue of forming an economic mechanism is mainly in the competence of the state, regardless of the share of public funding. In the proposed model, one-channel financing is considered as the basic situation established in connection with the existing regulatory instruments (Martynova, 2019).

2. The state reacts to changes in the values of criterion indicators characterizing the state of sustainability of the regional socio-economic system through monitoring key indicators of national health (Martynova, 2019). The achievement of the objective function is assessed by numerical criteria, based on reports. In accordance with the state program "Development of health care", target indicators and indicators have been established, the value of which characterizes the level of sustainability of SES:

- "satisfaction of the population with the quality of medical care, percentage";
- "mortality of the population of working age (per 100 thousand of the population of the corresponding age)";
- "mortality from neoplasms (including malignant ones) (per 100 thousand population)";
- "life expectancy at birth, years";
- "mortality from diseases of the circulatory system (per 100 thousand population)".

3. The control subsystem determines the rules for the functioning of the SES.

3 RESULTS OF THE STUDY

The presence of a system of administrative management of health care in the Russian Federation, which sets formal rules for the functioning of the system, as well as a strict dependence on the reliability, relevance and quality of incoming information about the state and changes in control objects, which have their own goals, the rules of functioning determine the possibility of using the mathematical apparatus of game theory (Neumann J. Von, 1970; Dixit, 2020) to formalize the task of choosing (design) economic mechanisms (Kulman, 1993, McCollell, 2016).

The key component of the analysis of economic mechanisms, in particular, and including games with asymmetric (incomplete) information in general, is the incentive compatibility condition introduced into scientific circulation by Hurwitz (Hurwicz, 1960). This condition is nothing more than a formal interpretation of the assumption about the rationality of the behavior of economic agents: everyone chooses what he considers best for himself, namely, a strategy is chosen, while everything that concerns the alignment of interests within the framework of the strategies chosen by agents is determined by the conditions games.

The structure of game dynamics can be summarized by two elements:

- Participant design: Forward game theory can be used to optimize the decision of each participant to choose an individual strategy in order to obtain maximum individual utility.
- Mechanism design: "inverse" game theory focuses on designing a game for a group of stakeholders, acting according to a chosen strategy. Auctions are a classic example of mechanism design.

We are interested in inverse game theory formulated from the point of view of artificial intelligence (AI) under the following constraints:

- the task of formalizing the game is not to optimize the strategy of each participant in the game, but to design the game around the behavior of rational participants (main example: auctions).
- multi-agent AI system - in our case, the number of agents is quite large, moreover, depending on the specific socio-economic system (specific region) and the moment of the formation of the game situation, the number of agents is different.

The most general definition, which can be applied to any interaction between economic actors, considers such interaction as a strategic game and calls the form of the game itself a mechanism.

A game is a description of how players (agents) can act, and what any set of their actions (strategies) will lead to. For example, if the formulation of the mechanism design problem is aimed at choosing an economic mechanism for financing health care, then from the point of view of the reverse game theory, the choice of the strategy of each medical organization (MO) is determined by the following features:

- a plurality of sources for the formation of monetary resources for the purchase of medical care by patients;
- a wide variety of financing systems and models: in addition to private financing, where the source of funds is direct payments by patients for their care and contributions from citizens and employers (in favor of their employees), it can be voluntary health insurance carried out by private insurers;
- there is a system of state financing of health care; it includes a system of compulsory (social) health insurance and a system of budgetary financing.

A more rigorous formulation proposed by Hurwitz (Hurwicz, 1960) defines the economic mechanism as the interaction between subjects (agents) and the center.

Then the design of economic mechanisms (mechanism design) is a constructive approach that allows you to create such a mechanism of interaction in which the egoistic actions of each of the agents in the sum will lead to a solution that is optimal from the point of view of the overall objective function formulated by the center.

State bodies (SB) exert an indirect influence on a medical organization (MO) through the territorial compulsory health insurance fund (TCIHF) and medical insurance organizations (MIO). Thus, in accordance with the current legislation of the Russian Federation, the dynamics of the strategies of the main stakeholders is determined according to the results of the interaction of the SB, MO, MIO and the patient (On Compulsory Medical Insurance in the Russian Federation, 2010; On the Fundamentals of Health Protection of Citizens in the Russian Federation, 2011) (Figure 1).
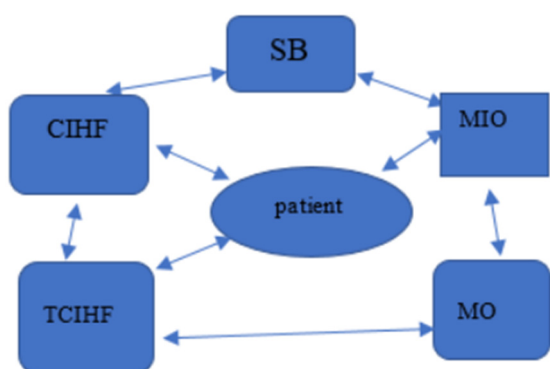
Figure 1: Scheme of information interaction of the main stakeholders in the CHI system at the regional level (Compiled on the basis of Vostropyatova and Levkevich, 2014).

The essence of the strategy game is the dependence of the appropriate choice of actions of each participant on the expectations of what the other will do. Game theory is traditionally divided into two branches: non-cooperative and cooperative. Cooperative game theory deals with situations where there are institutions that enter into agreements between players obliging them to implement the terms of the agreement. In such a game, the central issue becomes the question of agreeing on the best joint course of action (a set of individual strategies) of all players (stackholders), in which the best can have different values, for example, acceptable to all players and coalitions of players, or ensuring that some desired properties of the entire set of participants in the game, including the institution itself, which initiates the agreement.

General problem statement:

The payoff of each of the agents - medical organizations (MOk) - depends on the volume of the produced public good U_k, which for a period of time T is determined by the quasilinear function of social choice:

$$U_k = f(B_k, T, F_k)$$

Here, the quasilinear of the choice function is due to the fact that the total number of medical services $B_к$ provided by MOk during the time period T is calculated as an algebraic sum:

$$B_к = \sum H_{kij} + Q_к,$$

Where:

$\sum H_{kij}$ - the volume of medical services provided by the MOk and paid from a single determining source in accordance with the invoices;

Q_k is the volume of medical services provided by the MOk and paid for from all other sources;

t_{ni} - type MO_i (t1 - private medical organization; t2 - budgetary medical organization)

F_k is the total amount of financing of the Ministry of Défense; F_k is determined by the normative amount of funding from a single centralized source (currently: TCIHF) F_{kn} minus the fines imposed on the MO.

G (S1, S2 - Sn-1, Sn) - the result of the implementation of the control functions of the civil defence, determined on the basis of the MO strategies (for example, control of the volume, timing, quality and conditions of medical care), which forms the amount of fines.

MO_i provide medical care (to patients) in accordance with the chosen strategy $S_i \subset \{S1, S2, ... Sn\}$.

The content of the economic mechanism: the economic mechanism (EM) consists of (Figure 2):

- sets of strategies {S k} for each of the agents of the MO;

- G (S1 - Sn-1, Sn) - the function of outcomes, which determines the outcome of the game situation, provided by the economic mechanism for the input profile of strategies;
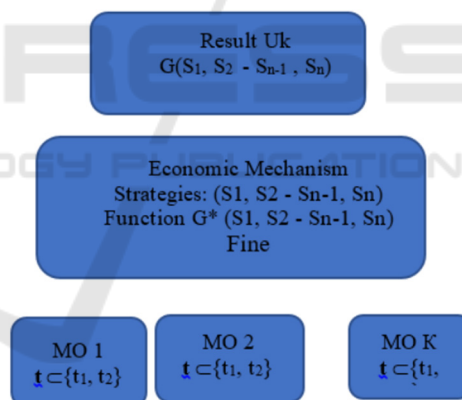
- values of fines (assigned by the state).

Figure 2: Formalized representation of the game situation.

In these keys, a version of a static game with complete information (McCollell, 2016) is considered in relation to determining the required amount of funding for the territorial health care system, assuming that agents (players) make decisions simultaneously and their decisions are not subject to revision.

4 THE DISCUSSION OF THE RESULTS

The state of sustainable development of SES in the region presupposes the presence of a definite outcome of the game. As a result of the game, the Pareto SES equilibrium is established.

The economic mechanism that ensures equilibrium is a condition for the sustainability of the development of the socio-economic system, since it provides the necessary level of public good Uk.

Equilibrium state: an economic mechanism that for a set of strategies (S1, S2 - Sn-1, Sn) and the normative level of financing the provision of medical services to the population Fk n ensures the equilibrium of the socio-economic system (Neck, 1983), diagnosed on the basis of the criterion of the produced public good Uk (Gorbunov, 2019). The "life expectancy at birth" is used as a criterion indicator.

Imbalance: the total funding Fk is less than the value of the minimum admissible level of funding MOk required to ensure the lower limit of the criterion indicator Uk; This situation does not allow, without attracting additional funding sources, the provision of the socially necessary volume of public goods - the provision of medical services.

5 CONCLUSIONS

A preliminary assessment of the possibility of designing specific economic mechanisms that ensure the solution of urgent problems of preserving the health of the population, showed the presence of a stable interaction between health financing and the level of sustainable development of the SES in the region. The issues of health care efficiency as a condition for sustainable development were considered, first of all, from the standpoint of assessing the dynamics of indicators of the national accounting system.

REFERENCES

Burkov V., Novikov D. and Schepkin A. (2008). *Management mechanisms for ecological and economic systems*. M: Fizmatlit.

Livshits S. (2003). *Features of financial resources management in treatment and prevention organizations of various forms of ownership*. http://medical-diss.com/medicina/

Kulman, A. (1993). *Economic mechanisms*. Per. with fr. E.P. Ostrovskaya, Common ed. N.I. Khrustaleva. M: Progress: Univer.

Akindinova, N. (2018). Cross-country analysis of the structure and efficiency of budget expenditures. *In Economic Issues*, 12: 5-27.

Panurin V. and Khan I. (2017). Strategies for the interaction of stakeholders in the compulsory health insurance system: the formation of a game model. In *NAUKOVEDENIE Internet magazine*, 9(5). https://naukovedenie.ru/PDF/ 18EVN517.pdf

Martynova, A. (2019). *Modern models of healthcare financing in Russia. In "State power and local self-government"*, N 6 . http://www.consultant.ru/law/podborki/odnokanalnoe_ finansirovanie.

Pyatakovich F., Lomazova V., Makkonen K., Nesterov V., Nesterova E. and Yakunchenko T. (2014). Multicriteria stakeholder analysis of investment innovation projects in the field of regional healthcare. In *Basic research*, (9-6): 4-10. http://cyberleninka.ru/ article/n/mnogokriterialnyy-steykholder-analiz.

Rizvanova, M. (2006). *Improving the financing of the health care system as a factor in increasing the human potential of the region (on the example of the Republic of Bashkortostan):* Izhevsk: GOU VPO "Udmurt State University".

On Compulsory Medical Insurance in the Russian Federation, (2010). No. 326-FZ. https://normativ.kontur.ru/document?moduleId=1&do cumentId=287865.

Vostropyatova M. and Levkevich M. (2014). *Stakeholders in healthcare. In Economy and social policy,* 10-14

Neumann J. Von (1970). *Game Theory and Economic Behavior*. ed. and with add. N.N. Vorobyov, Nauka Publishing House.

McCollell, A., Winston, M. and Green, D. (2016). *Microeconomic theory*. Book 2. (translated from English) M: Publishing house "Delo".

Neck, R. (1983). Modeling and Simulation of the Politico-Economic System for Austria. *In IFAC Proceedings*, 16 (12): 527-534. https://doi.org/10.1016/S1474-6670.

Gorbunov, Yu., Gorbunova A. and Solskaia I. (2019). The use of crisis management in ensuring sustainable food production by organizations of border areas. *In Published under license by IOP Publishing Ltd. IOP Conference Series: Earth and Environmental Science,* Volume 395, conference 1. https: //iopscience.iop.org/article/10.1088/1755-1315/395 /1/012095.

Zhuravlev, D. (2019). Organizational and economic mechanism for managing sustainable development of the region. In *Creative Economy*, 13(2): 249-260. doi: 10.18334 / ce.13.2.39905.

Hurwicz, L. (1973). The Design of Mechanisms for Resource. In The American Economic Review Vol. 63, No. 2, *Papers and Proceedings of the Eighty-fifth Annual Meeting of the American Economic Association*, pp. 1-30 Published By: American Economic Association

Hurwicz, L. and Reiter, S. (2008). *Designing economic mechanisms.* - New York: Cambridge University Press. https://books.google.ru/books.

Dixit, A. (2020). *Game theory. The art of strategic thinking in business and life.* 4th ed. M .: Mann, Ivanov and Ferber.

Gutman, G., Miroedov, A. and Fedin, S. (2002). *Regional Economy Management.* M .: Finance and statistics.

State program "*Development of health care*" (2017). Approved by the Government Decree of December 26, 2017 No. 1640. *The current edition of the state program "Healthcare Development".* URL:http://government.ru/rugovclassifier/855/events/ Date of treatment: 01.03.2021

On the Fundamentals of Health Protection of Citizens in the Russian Federation, (2011). No. 323-FZ. http://www.consultant.ru/document/cons_doc_LAW_121895/ Date of treatment 09.12.2020

Hurwicz L. (1960). *Optimality and informational efficiency in resource allocation processes/ In Mathematical Methods in the Social Sciences*. K. J. Arrow, S. Karlin, P. Suppes (eds.). Stanford: Stanford University Press.