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INSTITUTIONAL METHODOLOGY AND THE INSTRUMENTS OF THE NATURAL SCIENCE FOR THE DEVELOPMENT OF THE INNOVATION THEORY

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The grave shortcomings of the monetary valuation of the innovation processes and innovation projects are the general result of the money units' instability. That's why working out of the innovation valuation methodology, which methodology is based on the natural science approach, is an actual task, and also the objective of the work. Using the methods of the institutional economy, technological relations and functions theory and the technological orders conception, we worked out the original approach to the innovation projects' development. The approach gives a possibility to minimize the possibility of the existence of the innovation processes participants' opportunistic behavior, and to increase the efficiency of the innovation activities.

Key words: innovation, institutional economy, methods of the natural science, opportunism, research and development, technology adoption, technological orders.

JEL kodes: O32, O33.

1. Introduction

Working out the basis of the innovation theory was one of numerous steps to the development of the general theory of cycles and crises. Especial sense it has for the economy and technological sphere. For the three decades of the 20th century scientists devised the fundamentals of the innovation theory, which covered the technological, economic and sociocultural innovations (Saviotti, 2004; Furubotn, 1998; Linn, 1996).

Special attention was also paid to the interactions between the innovations and the economic growth. For example, this idea was a keynote of the Nobel Prize recipient's lecture by Simon Kuznets (1971). This author presented a number of the original approaches to the innovation theory, and developed the ideas of J. Shumpeter (1939) and D. Bell (1976). The last two decades was a period, when the development of the innovation institutions theory became an actual and prospective school (Perez, 2002; Akerlof, 2010).

One another feature of the economic methodologies' development is an intense development and wide use of the natural science and engineering methods for the economy and management. This approach became commonly held in the last 30 years. The reasons for this are: traditional explanations of economic processes and phenomena do not meet the requirements of modernity, financial data contradict the existing theoretical models installed cash cost estimates looks incomplete.

To descript the existing situation, we can make a well-known academician L. I. Abalkin's idea as a good quotation: "If the science's condition is a reason for dissatisfaction, the situation should be considered as a moment of the old paradigm's exhaustion, when it's time for the new one to exist. The appearance and subsequent strengthening of a new paradigm is a long and effortful process. On the first level the system of analogies can be used as a powerful stimulant: we should use the similar methods, adopted by the "sciences with good reputation". As an example, we can give the methodology of biology, genetics or thermodynamics. These methods are widely used for the analysis of the economic processes' cyclical dynamic and for the development of the evolutional economic theory in general." (Abalkin, 1994). A number of widely known researches of the last years cover the ideas of using the natural science methods for the economics and management (Dragulescu, 1999), (Stanley, 1996). Another argument is a position of Russian Foundation for Basic Research: the Foundation presents "the natural science methods for the humanities" as an actual nomination since 2013 (The competition…, 2013).

Examining the correlation between the monetary and natural measures of the economic system's functioning, we notice that this correlation is an indicator of converging of the natural and soft science. This process is a characteristic feature of the nowadays running scientific and technical revolution.

Using the general scientific conceptions from the natural science and technics in the economics gives a possibility for better understanding of such economic, and, in particular, production systems' features, as the lack of the constants among the processes' parameters; a rapid breaking of the established trends; time uncertainty of the specific events (such as a crisis); a low predictability of the economic developments' dynamics.

A well-known work by C. Perez "Technological Revolutions and Financial Capital" (Perez, 2002) deals with how necessary is the working out of the specific instruments for the crisis prognostication, and with the problem of the existing prognostication methods' imperfection. In this work author pays a special attention to the importance of the harmonic ratio of the technological and financial parameters, which parameters characterize the innovation processes.

The work by C. Perez was published before the beginning of the crisis of the 2008 year. The beginning of the crisis was also the period of growing interest in the aforesaid problem. G. Akerlof and R. Schiller (2010), in particular, began to build new macroeconomics the models of which, in their opinion, should consider trust, the effect of panic or schooling habit of market's agents, etc. They also noticed importance of developing new economic instruments on the base of the methods of natural science.

The whole set of methods from natural science and technics, which are widely used in the economics and management, is shown in figure 1.

A special role among these methods is played by the econophysics, a discipline, existed during the explorations of the capital issues yield dynamics and the distribution of the means and income in the society with the help of the statistical physics methods. This discipline also uses the quantum mechanics models to examine the interaction between the economic agents (they interact like the elementary particles). We mark out two basic ways of the development of the econophysics: the way, based on using of the thermodynamic models (Lux, 1999) and “the interdisciplinary way”, based on the complex using of the physical models and methods (Mantegna, 2000).

The numerous researchers in their works pay a great attention to the applicability of the institutional economy methods and methodology of the natural science for the innovation management. But the requirements for the development of this area include the working out of the specific economic instruments for.

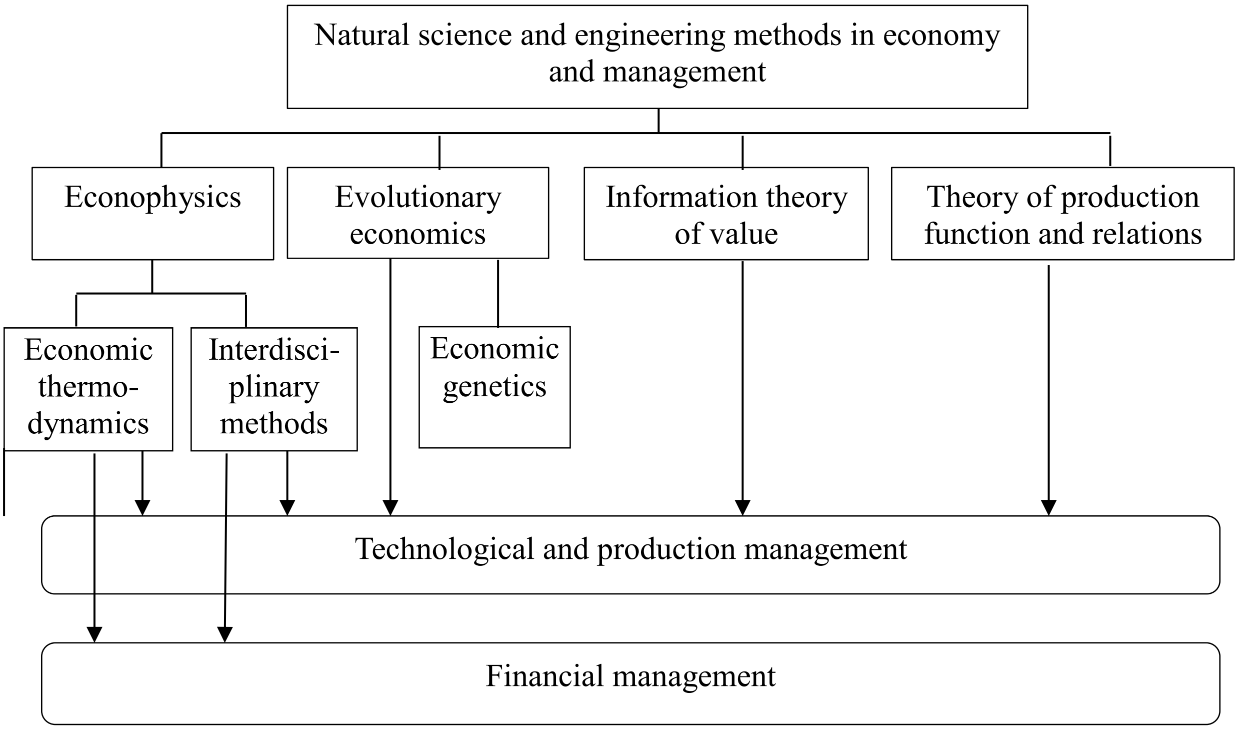

Fig. 1. Natural science and engineering methods in economy and management

The objective of our work is the analysis of the possibilities for the efficient using of the institutional approach and the methodology of the natural science for the solving of such problems of the innovation management as innovation projects evaluation and using these methods by the industry, agriculture and other sectors of the economy.

2. Methods

75 innovations projects, developed in 2005–2013 with the Southern-Russian State Polytechnical University and some small innovation businesses of the Southern

Federal District of Russia as the participants, were investigated. Analysis of the projects included the investigation of the information materialization level in the production systems, dimensional scale of the forming processes and the special features of the projects' commercialization. The expert evaluation of the commercialization processes participants' opportunistic behavior was also carried out by the professionals both of the research and development enterprises and of the customers.

As a research instruments we used the ideas of the technological relations and functions theory (Yun, 2001) and the technological orders theory (Glaziev, 2010).

3. Evaluation of the innovations and the technological orders

Choosing of a technology, or making other type of the decision during the development of the innovation project, and also choosing one of the possible innovations for the introduction provokes the appearance of the problem of evaluation, which problem may be sold by using the method of attributing the project to one or another technological order (Glaziev, 2010).

The quantitative characteristics of the technological order is the materialization level of the production systems' information, which level increases as far as the previous order is changed by the subsequent. The original approach to this idea is shown by O. M. Yun (2001), who examined the technological relations and functions, implemented by the production system (q.v. table 1). This approach should be used if we have to analyze the changing informational relations under the different technological orders.

Table 1. Technological relations and the production functions (Yun, 2001)

Technological relations type	Function number	Function name
Pragmatic	1	Goal-setting, choosing the product to manufacture
	2	Grounding the product characteristics
	3	Developing the action program for the industrial engineering
Syntactic	4	Choosing the possible technologies
	5	Choosing the technological relations
	6	Grounding the production relations system
Semantic	7	Developing the technological processes system
	8	Fine-tuning of the technological processes
	9	Combination of the manual labour and machinery work
Cognitive and Emotional	10	Developing the system of the instrumental regulators
	11	Means of the instrumental operations' regulating
	12	Regulating of the instrumental process
Material	13	Investment goods reproduction
	14	Product reproduction
	15	Instrumental operating a subject of labour

During their evolution, the informational content of the labour processes in the production systems changes greatly. The nature of the proper information medium, which determines the general appearance of the production system of one or another technological order, also changes. Basing on this statement, and the materials of (Pereyaslova, 2012), we present table 2, in which the informational processes are shown. These processes are being materialized, respectively, on the instrumental, machine and informational steps of the production development.

Another quantitative characteristic of the technological order is the forming processes' dimension scale. The forming processes should be analyzed for the dominating technology, which technology determines the economic result of the production (q. v. table 2).

Table 2. Timeframes and the basic characteristics of the technological orders

<table>
<tr><th rowspan="2">Time-frame</th><th rowspan="2">Dominant techno-logical order</th><th colspan="5">Characteristics of the technological order</th></tr>
<tr><th>Produc-tion deve-lopment step</th><th>Basic economic resource</th><th>Dominant management-concept</th><th>Level of the informa-tion's mate-rialize-tion</th><th>Dimension scale of the forming processes</th></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td rowspan="10">1830
1880
1920
1950
1980
1995
2015</td><td>1</td><td>Instru-mental</td><td>Materials (natural stuff)</td><td rowspan="2">Basic production management</td><td>15–11</td><td>1–0.2 mm</td></tr>
<tr><td>2</td><td rowspan="5">Machine</td><td rowspan="5">Energy</td><td rowspan="2">11–10</td><td>100–50 micron</td></tr>
<tr><td>3</td><td>Production management</td><td rowspan="3">50–10 micron</td></tr>
<tr><td rowspan="3">4</td><td>Management of the enterprise</td><td rowspan="2">9</td></tr>
<tr><td rowspan="3">Business management</td></tr>
<tr><td rowspan="3">8–6</td><td rowspan="4">10–0.5 micron</td></tr>
<tr><td rowspan="3">5</td><td rowspan="4">Infor-mational</td><td rowspan="4">Infor-mation</td></tr>
<tr><td rowspan="2">Cost management</td></tr>
<tr><td rowspan="2">5–2</td></tr>
<tr><td>6</td><td>Managing the technological efficiency</td><td>100–0.1 nanometer</td></tr>
</table>

The dimension scale value decreases as far as the previous order is changed by the subsequent. From the first to the forth order the reason for this regularity was based on the increasing of the mechanical engineering products' dimensional accuracy: the dimensional accuracy determined product's performance. The fifth order appearance is associated with the development of the microsystem electronics, which operates the dimensional parameters accuracy within microns.

Examining how much the information materialization level and the dimensional scale of the forming processes change, we follow the conceptual proposition that any point on the economic development trajectory is determined by the previous evolution of the production systems in general (Pereyaslova, 2012).

It's obvious that the sixths technological order should appear with the next decreasing of the forming processes' dimension scale. This statement corresponds to the result of the actual studies of the natural systems and leaving organisms, and processes in these systems, based on the interaction of the molecular and atomic size objects (size from 0.1 nanometer to 100 nanometer).

A transfer of the forming processes to the nanometer level, which takes place within the sixths technological order, leads to the conceptual changing of the economic instruments that are used for managing the production systems in general and, specifically, for the engineering services. It looks important that this situation makes possible a practical realization of the extremely efficient technology concept. This concept was worked out in the 1980th (Kalyagin, 1982) and considerably developed at the present time (Pereyaslova, 2012). Using this concept, we represent the technology, which assures a maximum possible base product yield (100% selectivity of the process) as the extremely efficient. The level of the real technology's compliance with the extremely efficient (the increasing of this level, first of all, makes the production cost per unit less) can play the role of the efficiency index for the production process.

4. Staving off the opportunistic behavior during the introduction of the innovations

The innovation process participants' opportunistic behavior is one of the great threats for the successful innovation activities. A number of the well-known authors share this opinion (Long, 2009; Wirtz, 2009). They also name an absence of the efficient project valuation system as a main reason for the appearance of the opportunistic behavior.

We consider that using of the natural science methods together with the methods of the institutional economic is the most promising way. As an example, they can be used to solve a problem of averting the market agents' opportunistic behavior.

Let's take a good look at this methodology, used for the contracts in the engineering design, R&D and engineering services market. In fact, we analyze the activities of the specific organizations, which activities are based on the transmission of the information and the property from the ones, who create the intellectual goods ("the manufacturers") to other players ("the consumers"). All the players should keep to the terms of the transmission.

In this situation the developers, which are interested in securing the order, can show an opportunistic behavior. It also takes place the information asymmetry – a situation, when the project customer ("the consumer") never gets the full information about the project parameters, and the developers don't know, in what way the customer is really going to use the project.

The probability of showing the opportunistic behavior, both by the sellers (or developers) and by the customers (or investors), decreases substantially if the players use the efficient instruments for the assessment, which instruments give a possibility to quantify the qualitative characteristics of the product. In this situation the most useful instrument is an integrated assessment, applied to compare the products, which's particular parameters are different. This kind of assessment for R&D is being applied as attributing of the analyzed project to one of the technological orders.

This approach requires using of the natural science and technics methods and instruments to solve a problem of choosing an optimal technological option. It's necessary to notice here, that numerous scientists paid a great attention to this problem, as to actual for the development an imperfection of the economic methodology and instruments. The integrated assessment of the product's confidence merits for the engineering services is the most available by the way of attributing of the analyzed project to one of the technological orders, as referred above.

All the aforesaid we present as a particular example of successful using the natural sciences' methodology to solve the R&D and engineering project organizational problems, which solutions are the part of the important transactional institution for the intellectual intermediation.

Project assessment, based on the determining of the production system to one or another technological order, is now successfully used by the "Polytech" engineering company and by the Southern-Russian State Polytechnic University (NPI) (Pereyaslova, 2013).

5. Conclusion

1. The objective of the carried out research is creating the methods of the innovation valuation based on the natural science approach, and removing the shortcomings, which are the general result of the money units' instability.

2. As a result of the working out of the research problems there was devised an approach to the innovation projects' development that includes the project valuation methods, based on the methods of the institutional economy, the ideas of the technological relations and functions theory and the technological orders conception. The presented approach gives a possibility to decrease the possibility level of the existence of the innovation processes participants' opportunistic behavior, and to increase the efficiency of the innovation activities.

3. It's ascertained that the most advanced (the sixth) technological order is attributed to the innovations, which meet the requirements of the forming dimensional scale of 100 – 0.1 nanometer and of the information materialization on the levels 5–2 (in accordance with O. Yun theory).

4. The described result may be interpreted as the evidence for idea that using of the institutional and evolutional economy methods for the innovation project management is a right decision.

5. We recommend to use the results of the research during the working out of the new technologies and for the innovation projects development.

References

1. Abalkin, L. I. (1994). Preface for the article "The Economic Evolution and Economic Genetics" by V. Mayevskiy // The Economic Issues. No. 5: 4–5.

2. Akerlof, G., Schiller, R. (2010). Spiritus Animalis, or how human psychology drives the economy. – Moscow: United Press. 111 p.

3. Bell, D. (1976). The Coming of Post-Industrial Societe. – Viddlesex: Penguin. 398 p.

4. Dragulescu, A. (1999). Application of Physics to Economics and Finance: Money, income, Wealth, and the Stock Market // Nature. Vol. 397: 498–512.

5. Furubotn, E. G., Richter, R. (1998). Institutions and Economic Theory. The Contribution of the New Institutional Economics. – Ann Arbor: The University of Michigan Press. 212 p.

6. Glazyev, S. (2010). New technological order and the nowadays world economy // The International Economy. No. 5: 5–27.

7. Kalyagin, Ju. A., Tsyrkin, E. B. (1982). Developing an algorithm of estimating the indexes of the extreme and the achievable technological efficiency for the petrochemistry // Using the mathematical methods and computer technologies for design and development of the processes for the petrochemistry. – Moscow: 167–172.

8. Kuznets, S. (1971). Economic Growth of Nations: Total Output and Production Structure. – Cambridge: Cambridge University. 223 p.

9. Linn, L. (1996). Linking technology and institutions: the innovation community framework // Research policy. Vol. 25. No. 1: 91–106.

10. Long, P. (2009). SMB Opportunistic Locking Behavior // Network Monitor. September: 123–129.

11. Lux, T., Marchesi, M. (1999). Scaling and Criticality in a Stochastic Multiagent Model of a Financial Market // Nature. Vol. 397: 498–512.

12. Mantegna, R., Stanley, H. (2000). An Introduction to Econophysics: Correlations and Complexity in Finance. – Cambridge: Cambridge University Press. 328 p.

13. Pereyaslova, I. G., Kolbachev, E. B. (2012). Technical and Economic Dynamics of the Production Systems and Its Accounting for the Innovative Projects' Developing // The Issues of South-Russian State Technical University (NPI). No. 5: 50–55.

14. Pereyaslova, I. G., Shmatkov, V. V. (2013). Forecasting and Monitoring of the Technical University Schools' Research Work // The Issues of South-Russian State Technical University (NPI). No. 4: 6–11.

15. Perez, C. (2002). Technological Revolutions and Financial Capital. – Cambridge: Cambridge University. 232 p.

16. Saviotti, P. P., Pyka, A. (2004). Economic development by the creation of new sectors // Journal of Evolutionary Economics. Vol. 14: 1–35.

17. Shumpeter, J. (1939). Business Cycles. – Philadelphia: Porcupine Press. 326 p.

18. Stanley, H., Amaral, L., Buldyrev, S. (1996) Can Statistical Physics Contribute to the Science of Economics? // Fractals. Vol. 4: 415–429.

19. The competition of the Research Project Initiatives in 2014, carried out by the Russian Foundation for Basic Research and The Deutsche Forschungsgemeinschaft. – http://www.rfbr.ru/rffi/ru/international_announcement/o_1892238 [24 10 2013].

20. Wirtz, J., McColl-Kennedy, J.-R. (2009). Opportunistic customer claiming during service recovery // Journal of The Academy of Marketing Science. September: 127–136.
21. Yun, O. M. (2001). Production and logics: The informational basis of the development. – Moscow: Noviy vek. 154 p.

GAMTOS MOKSLŲ INSTITUCINĖ METODOLOGIJA IR PRIEMONĖS INOVACIJŲ TEORIJOS PLĖTRAI

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Santrauka

Rimti inovacijų procesų ir inovacijų projektų įvertinimo piniginiais vienetais trūkumai yra bendras piniginių vienetų nestabilumo rezultatas. Dėl to rengiama inovacijų įvertinimo metodologija, paremta gamtos mokslų metodais. Darbo tikslas – naudojant institucinės ekonomikos metodus, technologinių santykių ir funkcijų teorijas bei technologinių užsakymų sampratą parengti originalią metodiką inovacijų projektų plėtrai. Ši metodika leidžia sumažinti egzistuojančias inovacijų procesų dalyvių oportunistinio elgesio galimybes ir padidinti inovacinės veiklos efektyvumą.
Reikšminiai žodžiai: gamtos mokslų metodai, inovacija, institucinė ekonomika, moksliniai tyrimai ir plėtra, oportunizmas, technologijų įsavinimas, technologiniai užsakymai.
JEL kodas: O32, O33.