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A Design of Innovative Development in the Industrial Types of Economic Activity

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ABSTRACT

The relevance of the problem declared in the article is conditioned by the fact that the swift acceleration of changes of the existing economic and institutional terms pushes off management entities with new problems that require new approaches and methods to be solved, that in future also will accelerate innovations and modernization transformations. The aim of the article is to develop with the use of cluster analysis the innovative development model of industrial types of economic activity. The leading approach to study this problem is a design method allowing conduct the level estimation of innovative development of economic sectors with the use of quality and quantitative indexes. The method of description, comparison, cluster and descriptive analysis are used in the article. Innovative progress trends are reflected in the article, systematization of factors of innovative activity is given and the factor and descriptive analysis of industrial types of economic activity is conducted. Materials of the article have theoretical and practical significance for development of innovations' management models, as well as for development of strategy of public innovative policy.

Keywords: Innovation, Innovative Activity, Cluster Analysis, Technological Innovations, Three-Spiral Model of Innovations
JEL Classifications: O31, O34, Q01

1. INTRODUCTION

Steady dynamic development in modern conditions is possible only on the basis of innovative type economy formation, development of key elements of the national innovative system. Passing to postindustrial society demonstrates the significance of activation of innovative processes as one of leading factors of the economy growth.

In the conditions of increasing competition of the national and regional innovative systems it is necessary to strengthen positions due to continuous perfection of production and development of innovative activity of managing entities. For innovative activity in order to become a real strategic resource of economy of Russian Federation, it is necessary to consider it as a major engine of socio-economic development. In transition to the post industrial economy the innovative activity is considered to be a transforming factor of the economy and social growth.

To the questions of theory and methodology of innovations and innovative development of the economic systems works of the following researches are devoted: Kingston (1984), Udwadia (1990), Rogers (1995), Swan et al. (1999), Asheim and Coenen (2004), Campbell et al. (2004), Yakovetz (2004), Leydesdorff (2005) and others.

Statistics of innovations is based on the following world principles:

- A successive scope by the statistical supervision of different types of economic activity and types of innovations.
- Development and use of a common conceptual framework, the relationship and continuity of indicators of innovative activity.
- Complexity of research in the innovation process, involving the inclusion of all its elements: Research and development,

the introduction of innovations into practice, the yield to the markets, the obtaining of the economic effect.
- Comparability ensuring with international standards (Oslo manual, uniform screening program - EU CIS).

At present, the modeling of innovative development in the industry as a key factor for sustainable economic growth are a particular relevance.

2. METHODOLOGICAL FRAMEWORK

2.1. Methods of Study

In the process of research the following methods were used: Analysis, synthesis, system analysis, systematization and generalization of facts, modeling, descriptive analysis, cluster analysis, comparison, description, analogies. Theoretical and methodological basis of the research were the works of Rogers (1995), Asheim and Coenen (2004), Campbell et al. (2004), Yakovets (2004), Shurkina et al. (2015).

2.2. Theoretical Base of the Research

The theoretical basis of the study is formed of the fundamental and applied works of foreign and domestic scientists, exploring the innovative development of economic systems involved in the development of management tools of the innovation and modernization development of the economy.

2.3. Stages of the Research

The study was conducted in three stages:
- On the first stage - the preparatory stage, the modern state the research problem was analyzed in the theory and practice of innovation management; the program of the research methodology was developed.
- At the second stage - the main stage - on the basis of statistical data a dynamic analysis of the factors and level of innovative activity of industrial economic activities' kinds was carried out, clustering of industrial economic activities' kinds was carried out on indicators of innovative activity.
- At the third stage - the final stage a systematization, interpretation and synthesis of research results were carried out; theoretical conclusions were refined; processing and presentation of the obtained results was carried out.

3. RESULTS

3.1. Systematization of Theoretical Approaches of the Category "Innovation"

World and Russian experience of the last decades has shown that diverse strategies of partial reforming of the economy does not give the desired effect and gradually are fading. The success of the reforms and modernization of economic systems provide structurally balanced and coherent efforts to build a system of markets and institutions that would ensure the progressive changes of core macroeconomic indicators. This requires in-depth theoretical concepts in the economic and innovative changes' management.

To the questions connected with the theory and methodology of innovative activity the works of many researchers are devoted. By definition Yakovets, innovation "is the introduction of new elements in various types of human activity that increase the effectiveness of these activities." It is noted that the concept of innovation is multifaceted and its understanding is not as easy as it seems. The author highlights the "edges" or hypostasis of innovation (Yakovets, 2004).

1. The contributing incentives to innovation: Yakovets notes that it is not enough to be reduced only to the enterprising nature of man, the desire to disrupt the established routine. According to the author, the main motivation contributing to innovation, are the growing human needs and competition for the best their satisfaction. Yakovets concludes that innovation "is a general sociological regularity, the engine and the motive force of the progress of society in all its multifaceted nature."
2. Sources and initiators of innovations: These initiators are:
   - Scientists, inventing new laws of natural, social, technological development, which offer ways to use new knowledge.
   - Inventors, offering innovations, methods of their using in practice and protecting their intellectual property with the help of patents.
   - Entrepreneurs, managers, investors, bankers, developing new forms of company management or investing in the implementation of innovations.
   - Creative professionals, developing spiritual sphere of society: Musicians, writers, filmmakers, teachers, etc.
   - Political and public figures, creating new forms of organization of political life, political parties, the legal norms of interstate relations.
   - Military leaders, offering more effective ways of warfare, the use of weapons.
3. The level of innovation novelty: In general, the term "innovation" means phenomena which are quite different by nature, level of novelty and sizes of consequences of their implementation: Epoch, base, improving, micro innovations, pseudo innovation and anti-innovations.
4. The types of innovation: The classification by their implication is proposed: In technological, environmental, economic, socio-political, state and legal sphere, innovations in the spiritual sphere, in military and rule of law.
5. Spatial sphere of innovations: Depending on the level of novelty the innovations have different spatial distribution. Epochal and basic innovations, spreading from the epicenter, gradually cover the entire territory inhabited by people. Field of action of improving innovations may be restricted by country, region and city. Micro innovations (the author here uses the term "point") are limited to the enterprise, society.

Kingston notes that innovation "is the process of a new idea or invention's converting into a socially significant product with innovative technical and economic parameters or transformation of ideas into concrete objects" (Kingston, 1984).

Udwadia defines innovation as ".... relating to: (a) The adoption of a new activity or technology which are new for the organization;

(b) changes in the structure of the organization or used in it of management practices; (c) adaptation to market conditions of the results of internal corporate investigations and processes of organizational development" (Udwadia, 1990).

In accordance with the procedural approach, innovation is understood as the development and implementation of new ideas by people who over extended periods of time interact with other people in an institutional context. Innovation is not a simple linear phenomenon, but rather a complex multi-step process that involves cycles of both direct and feedback (Swan et al., 1999).

The theory of diffusion of innovations is fully reflected in the works of Rodgers, who defines innovation as an object, idea or action which are perceived by the consumer (human or organizational structure) as new ones. There is also a special kind of innovation - preventive innovations - such ideas or solutions which are produced in order to avoid certain consequences or events in the future. The authors of this theory understand the diffusion (spread) of innovations as the process by which new ideas, technologies and proposals are circulated among the members of a social system through communication channels within a certain period of time. Social system in the theory of innovations diffusion is defined as a group of interrelated elements, united by a common process of problem or tasks solving to achieve a common goal. The elements or members of a social system may be individuals, informal groups, organizations, etc. In the context of studying of innovations' diffusion the structure of social systems, group norms and patterns of decision making within them are investigated, as well as the organizational changes that appear in these social systems due to the implementation of innovations. The communication channel is a means of information exchanging about innovations between elements and substructures of the social system.

In the process of innovations' diffusion one of the important factors is time. The time factor in innovations' diffusion by the authors of the concept is presented in the following forms.

1. The Stage of decision making about innovation:
   - Obtaining by the consumer of initial knowledge about the innovation
   - The formation of his attitudes to it
   - A decision generating on acceptance or rejection of the innovation
   - The production of a model of its realization and implementation
   - Confirmation of the accepted decisions regarding innovation.
2. The rate of assimilation of innovation is the relative speed with which it is accepted by members of a social system. It usually corresponds to the number of members of this system, adapting the innovation in a certain period of time. The tempo of the assimilation of innovations is greatly impacted by the following characteristics:
   - Relative advantage is the preference level of the perceived innovations in comparison with the element of the system which is replaced by it (linked to specific conditions of operation of the element and the system as a whole, the factors of prestige, convenience, satisfaction, etc.)
   - Compatibility - the level of consistency with existing values, past experiences, and needs of the consumer
   - Difficulty - the level of perception, assimilation and practical use difficulty of innovations
   - Testability - the ability to analyze the innovation and assess its effectiveness
   - Observation ability - the degree of results availability of innovation for strangers.
3. Being innovative one of innovation's user, which determines how much sooner he accepts and internalizes them in comparison with other members of the social system. Due to the fact that consumers of innovations can be both individual and social system, for a more complete and exhaustive analysis of innovation it is important to conduct the study at three main levels: Organizational, group and personal (Rogers, 1995).

Thus, the variety of theoretical approaches to defining of "innovation" category points to their importance and relevance for the development of economic systems.

3.2. The Analysis of Innovative Activity Dynamics in the Industry

Analysis of the dynamics of industrial enterprises' innovation activity, since 1994, has allowed reveal the following trends. For the observation period, the rates failure of industrial enterprises engaged in technological innovation is typical, from 19.5% in 1994 to 5.5% in 1995. Then there was a sharp, but not high enough rates growth to 10.6% in 2000, but nonetheless, to date, the indicators are fairly small - about 10%. In 2009, the percentage of organizations that carried out innovation activities in the total number of organizations accounted for only 9.4%. In 2013, the value of this indicator amounted to 9.9%. In international and Russian statistics other relative indicators of innovative development are also known: The share of innovative goods, works, services in the total volume of shipped goods, performed works and services; the share of expenditure on technological innovations in the total volume of shipped goods, performed works and services; the proportion of small enterprises engaged in technological innovation in the total number of small enterprises (Federal State of Statistics Service).

The value of the indicator "share of innovative goods, works, services in the total volume of shipped goods, performed works and services" increased from 4.6% in 2009 to 7.8% in 2013, the share of expenditure on technological innovation in the total volume of shipped goods, performed works and services for the analyzed period did not exceed 2%. The proportion of small enterprises engaged in technological innovation in the total number of small enterprises increased from 4.1% to 5.1%.

In 2013, among industrial economic activities the share of organizations engaged in technological innovation, manufacturing industries amounted to 11.9%, mining - 6.4%, and for the production and distribution of electricity, gas and water - 4.7%. Among refining industries, the largest share of organizations implementing technological innovations belonged to the enterprise's with economic activities "production of oil products"

- 27.1%, "production of electrical, electronic and optical equipment" - 25.9%, "chemical production" - 23.0%. It should be noted that for the 5-year period from 2009 to 2013, the industrial differentiation of types of economic activity began to reduce. This suggests that innovative activity is becoming a core factor of competitiveness and development of manufacturing not only in high-tech sectors, but also in the rest of them. For example, the variation scope of the level of innovative activity decreased from 30.1 in 2009 to 23.9 in 2013, as for variance - from 78.4 to 58.8. The obtained values of asymmetry and excess were less than 1, which also allows make a conclusion on the reduction of differentiation on the level of innovative activity in the industry (Table 1).

In 2013, the largest share of innovative products in total volume of shipped products belonged to businesses of economic activity types "production of transport equipment" - 28.1%, "production of oil products" - 15.2%, "production of electrical, electronic and optical equipment" to 10.7%. For aggregate industrial economic activity the following the ratio of this indicator was observed: "Refining manufacturing" - 11.6% (in 2009-6.1%), "mining" - 6% (2.7%), "production and distribution of electricity, gas and water" - 0.8 (1.5%).

3.3. International Comparisons of Innovative Activity Level

International comparisons of the level of innovative activity showed that in Russia it is below the level of Germany in 7.7 times, of Belgium - 5.9 times, of France - 5.2 times, of Japan - 4.7 times and Poland - 2.7 times.

The intensity of expenditure on technological innovation in 2012 was 2.52 (for comparison, in Denmark - 3.45, Finland - 2.93, Sweden - 2.91).

In the structure of expenditure on technological innovations at Russian industrial enterprises dominated investments of low order - the largest share belonged to the acquisition of machinery, equipment and software, the percentage of research and development accounted for 22.6%, which is significantly below than the level of European countries.

3.4. The Industrial Clustering of Economic Activities by the Level of Innovative Activity

Using of the methodology of cluster analysis allowed grouping the industrial economic activities in two indicators: Share of organizations implementing technological innovations and the share of innovative products in the volume of shipped products. 4 clusters were received (Figure 1).

Table 1: Descriptive statistics of organizations' proportion engaged in technological innovation

Year	Scope	Variance	Standard deviation	Asymmetry	Excess
2009	30.1	78.5	8.9	1.0	0.1
2010	27.2	64.8	8.1	0.9	0.0
2011	28.9	68.9	8.3	1.0	0.3
2012	28.8	73.0	8.5	0.9	0.1
2013	23.9	58.9	7.7	0.8	−0.6

Descriptive statistics for each cluster are shown in Table 2.

The first cluster ("leaders") corresponds to high values of the share of innovative products in shipped products and the share of organizations implementing technological innovations. Cluster of leaders is presented by 4 types of economic activity: Production of coke and oil products, chemical production, production of electrical equipment and production of vehicles.

The second cluster is formed by 4 types of economic activity and it includes the production of rubber products, metallurgical production, production of machinery and equipment, other productions. This cluster is called as "candidates for the leadership." The economic activities of this cluster had high in comparison with other sectors the values of the specific weight of innovative products in shipped products and the share of organizations implementing technological innovations.

The third cluster ("followers") was the most numerous - 5 economic activities: Mining, production of food products, textile and garment production, leather production, production of other non-metallic mineral products. This cluster had lower values in comparison with clusters of leaders and candidates for leadership.

The fourth cluster ("niche") included 3 types of economic activity: Wood processing, pulp and paper production, production and distribution of electricity with the lowest values of indicators of the share of innovative products in shipped products and the share of organizations implementing technological innovations.

Thus, modeling of industrial innovative development of economic activities on the basis of descriptive statistics and cluster analysis allowed the grouping of industries according to the level of innovative activity. The results obtained can be used to develop measures to stimulate innovation activities of economic sectors taking into account their innovation potential.

4. DISCUSSIONS

In connection with the above written information, a particular urgency has the solution to the problem of the elaboration of new models of innovation management.

The model of institutionalization of sustainable innovative development of economic systems is based on triple helix model

Figure 1: The results of the industrial clustering of economic activities by the level of innovative activity

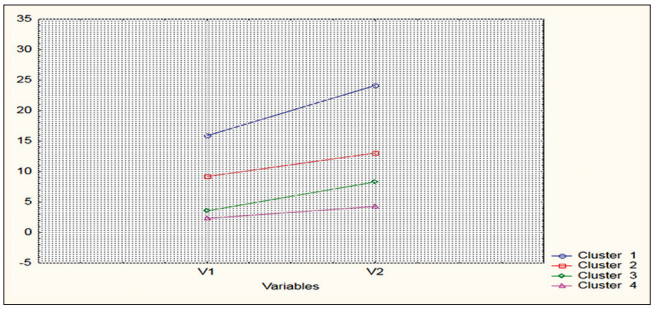

Table 2: Descriptive statistics for the clusters

	Economic activity	Share of innovative products in shipped products, percentage	Share of organizations implementing technological innovations, percentage
Cluster "leaders"			
Average value	The production of coke and oil products, chemical production, production of electrical equipment, production of vehicles	15.9	24.1
The standard deviation		8.4	3.0
Cluster "candidates for leadership"			
Average value	The production of rubber products, metallurgical production, production of machinery and equipment, other manufacturing	9.2	13.0
The standard deviation		3.3	2.1
Cluster "followers"			
Average value	Mining, production of food products, textile and garment production, leather production, production of other non-metallic mineral products	3.6	8.2
The standard deviation		1.6	1.7
Cluster "niche"			
Average value	Wood processing, pulp and paper production, production and distribution of electricity	2.3	4.3
The standard deviation		1.3	1.0

of innovations (The Triple Helix Model of Collaboration). The model in its base has new technologies of cooperation in innovations sphere between business, science (universities as an innovative communication centers) and the state with emphasis on commercialization, allowing to avoid institutional traps (situations of preservation of closed and inefficient from the standpoint of the sustainability of innovative development trajectories that are optimal for the two entities - the local optimum ("anti- institute of innovations"), typical for double helix models of innovation.

This model of cooperation contributes to the emergence of new forms of interaction between industrial consortia, universities and government agencies, with emphasis on commercialization (Asheim and Coenen, 2004; Campbell et al., 2004; Shurkina et al., 2015). A generalization of the existing experience shows that the controlled cooperation in the framework of the model helps to overcome institutional traps, providing a balance between knowledge, positive externalities of innovation for society and for the entrepreneur. Trilateral cooperation is intensifying partners to solve local problems and national interests through funded research programs, thus using human and material resources to create solutions, while ensuring the generation of new knowledge.

A partnership can greatly facilitate the diffusion of innovations, creating institutional conditions for the formation of a flexible network of innovative structures. Triple helix model of innovations allows create long-term organizational structure, which can suggest intensive implementation of specific innovative projects. As major institutional benefits of triple helix of innovations in modern economic literature the following things are mentioned: Meeting the challenges of research funding and improving of the scientific research efficiency (Leydesdorff, 2005; Jerome and Jordan). A common technological traps' elimination between science and production in the proposed model of innovations is reached due to the fact that in triple helix relations the government is more often in the center and not on the periphery of national, regional and multinational innovation systems.

The proposed model for the creation of centers of innovative communications on the base of triple helix model of innovations should solve the problem of the existence of the following traps within double helix models:

a. "Science-business" (local optimum as a consequence of the specialized closed technological trajectory - the technological trap).
b. "Science-state" ("failures" of government support for innovation).
c. "State-business" (the "Dutch disease" as a result of industrial policy (commodity business) and negative transaction effect of innovative development (for medium and low-tech industries) due to the virtual absence of industrial policy).

The initiator to overcome the local optima and innovations, accompanied by negative externalities to develop the meso-systems and provide a global optimum, in the framework of the proposed model should be the state as a development institution. The organizational form to implement the model is proposed communications centers on the basis of national research universities.

The mechanism of models' implementation is related to the formation of the Institute for the innovations' diffusion support as a set of rules, obligatory for support obtaining (reducing of transaction costs).

It is proposed to institutionalize the parameters of innovative activity of economic systems - consumers of R and d results - on the base of the developed parameters' set of quantitative model to estimate the level of innovative development of economic systems that directs the entities of the innovation process on the routines of innovation. The mechanism to overcome the institutional traps belongs to the innovative initiatives of the third part on the level of double helix model.

Thus, on the base models use of the global optimum in innovative development through the integration of science, business and state the expected reduction of the preconditions of rotation

and consequently the extension of the multiplicative effect of autonomous investment take place by "completing" of the Russian value chain in different sectors of the economy. In parallel with this the sustainability of innovative development by small, medium and large enterprises is ensured - sources of demand for domestic competitive development.

The previous researches were made by Kingston (1984), Udwadia (1990), Rogers (1995), Swan et al. (1999), Asheim and Coenen (2004), Campbell et al. (2004), Yakovets (2004), Leydesdorff (2005).

However, the analysis of scientific works devoted to the problem of modeling of innovative activity of the industrial sector of the economy is not structured and is only discussional by nature.

5. CONCLUSION

In this connection, we have proposed a sectoral typology of diffusion, which embraces vertical, horizontal, and matrix patterns. We strongly believe that key traditional industries (so called "basic economic activities" in Russia) are not less important for promoting modernization and supporting economic growth than hi-tech ones.

Increased attention to health and environment protection during last decade results in rise of popularity of biomedicine and sustainable development concepts, so the knowledge-based economy is considerably dependent on industry. In the article a case of industry's support and promotion in Russian Federation has been presented. Three types of economic activities from the national statistic RNCEA database, - food, agriculture and chemical industries - were proved to be the most important ones for diffusion of industry-related innovations. Those sectors are traditionally related to industrial modes 4 and 5 and generally may act as a base for hi-tech growth and transition to knowledge-based economy (technological mode 6).

Russian Kaluga, Tatarstan and Moscow provinces were additionally chosen to study sectoral patterns of diffusion of innovation in the sphere of industry. First of all, strong local scientific base and infrastructure are confirmed to be positively bound with promotion of diffusion.

It is established that the determining factor of innovative development of economic systems is the level and dynamics of innovative activity in industrial sector of the economy. On the basis of economic-mathematical modeling the industrial clusters of economic activities on the level of innovation development are allocated.

The proposed technique of clustering of economic activities and a model for the institutionalization of sustainable innovative development of economic systems is based on triple helix model of innovations and allows their positioning, segmentation and ranking.

The materials of the article have theoretical and practical significance for the development of innovations models management as well as for the strategy development of the state innovation policy.

Taking into account the obtained results of this study a number of scientific challenges and promising areas that require further consideration can be allocated: The deepening and widening of certain provisions contained in the article related to the assessment of the level of innovations in the industry.

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