ST. PETERSBURG STATE POLYTECHNICAL UNIVERSITY JOURNAL

Economics

5(251) 2016

ST. PETERSBURG STATE POLYTECHNICAL UNIVERSITY JOURNAL

The journal is published under scientific and methodical guidance of the Russian Academy of Sciences since 1995.

НАУЧНО-ТЕХНИЧЕСКИЕ ВЕДОМОСТИ

САНКТ-ПЕТЕРБУРГСКОГО ГОСУДАРСТВЕННОГО ПОЛИТЕХНИЧЕСКОГО УНИВЕРСИТЕТА

Экономические науки

5(251) 2016

НАУЧНО-ТЕХНИЧЕСКИЕ ВЕДОМОСТИ САНКТ-ПЕТЕРБУРГСКОГО ГОСУДАРСТВЕННОГО ПОЛИТЕХНИЧЕСКОГО УНИВЕРСИТЕТА

Contents

Содержание

S.V. Palash

THE MANAGEMENT OF STRUCTURAL CHANGES IN THE ECONOMY OF A REGION: PRINCIPLES, CRITERIA AND INDICATORS SYSTEM OF EFFICIENCY EVALUATION (by the example of industry of the Kostroma region)

С.В. Палаш

УПРАВЛЕНИЕ СТРУКТУРНЫМИ ИЗМЕНЕНИЯМИ В ЭКОНОМИКЕ РЕГИОНА: ПРИНЦИПЫ, КРИТЕРИИ И СИСТЕМА ПОКАЗАТЕЛЕЙ ОЦЕНКИ ЭФФЕКТИВНОСТИ (на примере промышленности Костромской области)

The relevance of the study is determined by the necessity of transition of the Russian economy to a new model and a new quality of economic growth, which is possible through introducing structural reforms in the economy, and is a component of economic development. The purpose of the study is in developing methodological and procedural foundations for estimating the quality and efficiency of structural changes in the economy. The objectives of the study are to give a brief evaluation of the industry in the Kostroma region as a control object of structural changes; to formulate the principles of structural changes management in the economy (industry); justify the selection criteria of the purpose, methods, and tools to manage structural changes in the economy (industry) and requirements for the subjects of management of structural changes; develop principles, criteria and indicators for assessing the quality of structural changes in the economy (industry); to propose criteria and system of indicators of an efficiency estimation of structural changes management in the economy (industry) for the controlled and controlling systems. The research methodology is based on a systematic approach. The method of study is economic analysis. It is possible to allocate the following features of the conducted research and the results obtained: principles, criteria and systems of indicators were developed on the basis of the principle of consistency as a core of system philosophy; the author offers a system of indicators to assess structural changes in the object, project, process and environmental systems on the basis of the classification of economic systems proposed by Kleiner; the structural changes themselves are considered as process and project systems with the appropriate features and specifications; the industrial complex as control object of structural changes is also considered as a set of systems of different types. The methodology and procedures for assessing the quality and effectiveness of the management of structural changes in the economy should act as a support for achieving the goals of state development programs and for improving the efficiency of state management of the economy of the region. Continuous monitoring of structural changes in the economy of the region and its industry will allow to timely identify structural problems and their aggravation, and to direct the available resources to resolve these problems. The proposed methodology and procedure will provide a systematic management of structural changes in the economy and industry of the region. The scope of application of the obtained results is the structural policy, the management of structural changes in national, regional economy, economic complexes, industry.
MANAGEMENT OF STRUCTURAL CHANGE; REGIONAL INDUSTRY; EFFECTIVENESS EVALUATION OF MANAGEMENT; METHODOLOGY AND PROCEDURE.

Актуальность исследования определяется необходимостью перехода российской экономики на новую модель и новое качество экономического роста, который возможен при условии структурных преобразований в экономике, являющихся составляющей экономического развития. Целью исследования стала разработка методологических и методических основ оценки качества и эффективности структур-

ных изменений в экономике. Задачи исследования: дать краткую оценку промышленности Костромской области как объекта управления структурными изменениями; сформулировать принципы управления структурными изменениями в экономике (промышленности); обосновать критерии выбора цели, методов и инструментов управления структурными изменениями в экономике (промышленности), а также требования к субъектам управления структурными изменениями; разработать принципы, критерии и систему показателей оценки качества структурных изменений в экономике (промышленности); предложить критерии и систему показателей оценки эффективности управления структурными изменениями в экономике (промышленности) для управляемой и управляющей систем. Методология исследования: системный подход. Метод исследования: экономический анализ. Можно выделить следующие особенности проведенного исследования и полученных результатов: принципы, критерии и системы показателей разработаны исходя из принципа системности как ядра системной философии; предложены системы показателей для оценки качества структурных изменений объектных, проектных, процессных и средовых систем на основе классификации экономических систем Г.Б. Клейнера; сами структурные изменения рассматриваются как процессные и проектные системы с соответствующими особенностями и характеристиками; промышленный комплекс как объект управления структурными изменениями анализируется как совокупность систем разного типа. Методология и методика оценки качества и эффективности управления структурными изменениями экономики призваны стать методологическим и методическим обеспечением достижения целей государственных программ развития и повышения эффективности государственного управления экономикой региона. Постоянный мониторинг структурных изменений в экономике области и ее промышленности позволит вовремя сигнализировать о структурных проблемах и их обострении, а также направлять имеющиеся ресурсы на решение этих проблем. Предлагаемые методология и методика обеспечат системность управления структурными изменениями в экономике и промышленности области. Область применения полученных результатов: структурная политика, управление структурными изменениями в национальной, региональной экономике, хозяйственных комплексах, промышленности.

УПРАВЛЕНИЕ СТРУКТУРНЫМИ ИЗМЕНЕНИЯМИ; РЕГИОНАЛЬНАЯ ПРОМЫШЛЕННОСТЬ; ОЦЕНКА ЭФФЕКТИВНОСТИ УПРАВЛЕНИЯ; МЕТОДОЛОГИЯ И МЕТОДИКА.

Introduction. The need for structural changes in the economy, including the development of domestic industrial production and import substitution, is recognized not only by the scientific community [2, 12−14, 23], but at the federal level of management of the economy. This is evidenced by the changes in the institutional environment: the Federal law no. 488-FZ 'On industrial policy', which came into effect in 2015, as well as the 'Plan to promote import substitution in industry', approved by Order of the Government of the Russian Federation on September, 30 2014 no. 1936-p, under which the federal executive authorities formed sectoral action plans for import substitution approved by numerous orders of the Ministry of industry and trade of the Russian Federation of March, 31, 2015 no. 650, no. 653, no. 658, etc. The developed and adopted legislative framework regulates structural changes in the domestic industry, however, implementing the plans for structural change and, in particular, import substitution faces a lot of obstacles, which are dysfunctions of management: dysfunctions of goal-setting, planning [24], organization, coordination [27], control, etc.

Evaluation of the efficiency of managing the structural change in the economy is a subsystem of control. Completeness and quality of maintaining the functions of control depends on the completeness and quality of implementation of other management functions.

The proposed methods are part of the procedure for assessing the structural balance of the economy, whose necessity and practical significance are determined by the objectives of government economic policy and a number of regulations that reflect these goals. In particular, one of the five state programs of the Russian Federation is 'Balanced regional development' [28]. In addition, the strategic goal of the state program of the Russian Federation 'Development of industry and increasing its competitiveness', approved by decree of the Government of the Russian Federation dated April,15, 2014 no. 328 'is the creation in Russia of a competitive, stable and structurally balanced industry...'. In the passport of the state program of the Kostroma region 'Economic development of the Kostroma region for the period up to 2025' the following is established as the goal of the program: 'Creation of conditions for

sustainable and balanced economic development of the Kostroma region'. One of the objectives and subprogrammes is 'the formation of a competitive, sustainable, structurally balanced industry in the Kostroma region'.

Thus, the methodology for estimating the structural balance of the economy should become a basis for achieving the goals of the state development programs and improving the efficiency of state management of the economy of the region. Continuous monitoring of structural changes in the economy of the area will allow to timely identify the structural problems and their aggravation, and to direct the available resources to resolve these problems. From the point of view of the author, a systematic approach, aimed at maintaining the balance of labor resources, investments, and innovations necessary for the development of the region and its industry. is needed to deal with the structural problems of the regional economy. The proposed methodology and procedure will provide a systematic approach to managing the structural changes in the economy of the region.

The article describes the characteristics of the process of managing the structural changes in the economy and industry. The paper examines the regional aspects of this process. The author develops methodological and procedural foundations for assessing the quality and efficiency of the management of structural changes in the economy (industry).

Theory and methodology of research. The research methodology is a systematic approach. A significant contribution to the development of the systematic approach was introduced by L. von Bertalanffy, A. Bogdanov, A. Rapoport, N. Wiener, I.V. Blauberg, D.M. Gvishiani, V.N. Kostyuk, V.N. Sadovsky, E.G. Yudin, L.V. Kantorovich [7], R.L. Ackoff, W.R. Ashby, L. Zadeh, M. Mesarovic, K.A. Bagrinovskii, G.G. Malinetskii, V.A. Volkonsky, G.B. Kleiner, V.N. Livshits, D.S. Lvov, A.L. Lurie, N.Ya. Petrakov, I.V. Prangishvili [18] Y.A. Schreider [25], Yu.I. Chernyak and others.

The structural analysis of the economy within the framework of the general theory of systems was studied by A.I. Anchishkin [1], L.V. Kantorovich [7], Yu. V. Yaremenko [26], A.N. Efimov [17], L.J. Berry [17], D.S. Lvov

[13−15], V.N. Livshits [12], G.B. Kleiner [8−10, 16], R.S. Greenberg [5], O.S. Sukharev [22], [23] S.D. Bodrunov [2] and others.

The main object of analysis of the systemic economy is the the relationship between the structure and functions of the systems [10]. From the point of view of system approach, due to internal diversity and external multifunctional nature of every economic system, its operation can be viewed from different perspectives and be described by different characteristics [16].

In accordance with the classification of economic systems by Kleyner, which distinguishes between object, design, process and environmental systems [9], structural changes in the economy (industry), from the point of view of the author, can be seen in the following aspects (planes): (a) structural changes within the complexes object, project, process, and environmental economic systems; (b) structural changes of the relationships and interconnections between systems of different types (for example, between object and process systems, etc.); (c) structural changes, recruitment and completeness of implementation of functions of economic systems. At the same time, structural changes can be regarded as economic systems of different types: a) structural changes as a process; b) structural changes (within an internally managed controlled or controlling system, between the controlled and controlling systems) as a project of a management system. Structural changes as projects require assessment of effectiveness.

It is known that the general criterion of efficiency is the economic performance of the managed subsystem as a whole, that is, how the enterprise (or organization) achieves its mission at minimum costs. The concept of 'efficiency' was originally associated with Pareto, whose idea of efficiency became the basis for further research in this area. Because 'efficiency' is one of the central concepts of economic science, the theory of efficiency developed by many scientists: M. Allais, N. Kaldor, J. Hicks, T. Scitovski, A. Bergson, R. Zerbe etc. The Cobb−Douglas production function was used as a model for measuring the economic efficiency for a long time. Leibenstein complemented the theory of efficiency with the concept of X-efficiency. The definition of efficiency was also given by the representatives of institutional analysis (North). P.L. Vilensky [3], A.L. Weinstein, A.G. Gryaznova,

L.V. Kantorovich, G.B. Kleiner, R.M. Kachalov, V.V. Kossov, V.N. Livshits [3, 11], D.S. Lvov, and S.A. Smolyak [3], A.G. Shahnazarov all made contributions to the development of evaluation of efficiency of investment projects. Sukharev shows the necessity of developing approaches to measuring adaptive efficiency, one of which may be an approach for measuring the degree of dysfunctionality of the system [21]. Because 'every economic system can be evaluated from the point of view of its functions, that is, systematically performed actions in relation to the super-system whose part it makes up' [16], the concept of ineffectiveness is associated in the scientific literature with the concepts of dysfunction and the dysfunctional system [16, 20]. In our opinion, complete execution of system functions in relation to the meta-system can be considered as an important criterion for evaluating the performance of the system.

The process of managing structural changes in the economy and industry

In order to make the desired structural changes in the economy (to increase output and share in GDP of the manufacturing industry, including high-tech; the amount and proportion of export of machinery, equipment, including high-tech), a set of measures is necessary covering structural, industrial, investment, financial, innovation, regional policy, etc., adequate institutional and methodological support of the processes of structural change and investment, innovation and personnel able to implement these structural changes. In order to create the conditions necessary for the formation of the desired structure of the economy, it is necessary to answer a number of questions:

A)characterizing the management process:

1)What is the structure of the Russian (regional) economy and the Russian (regional) industry, as its subsystem? (object of management)

2)What structure of the Russian (regional) economy and the Russian (regional) industry as its subsystem should be formed? (goal of management)

3)What are the methods and tools to achieve this goal? (methods and management tools)

4) What organizational structure will manage these changes? (subjects of management) What

requirements should be placed on the subjects of management of structural change?

B)characterizing the process of managing structural changes in the economy (industry):

1)What are the principles of managing the structural changes?

2)What are the criteria for selecting the target of managing?

3)What are the criteria for selecting the methods and management tools?

C) describing the methodology and procedure for evaluating the quality of the structural changes in the economy (industry):

1) What are the principles of evaluating the quality of the structural changes?

2) What are the criteria for evaluating the quality of the structural changes?

3) What is the system of indicators for measuring the quality of the structural changes?

D) describing the methodology and procedure for evaluating the efficiency of managing the structural changes in the economy (industry):

1) What are the principles for estimating the efficiency of managing the structural changes?

2) What are the criteria for evaluating the effectiveness of managing the structural changes?

3) What is the system of indicators for estimating the efficiency of managing the structural changes?

The author answers these questions and develops methodological and procedural foundations for estimating the efficiency of managing the structural changes in the economy (industry).

Industry in the Kostroma region as an object of managing the structural changes

Let us consider the object of managing the structural changes on the example of the industry inthe Kostroma region and describe a number of basic processes: the process of changes in the industrial structure, the investment process, foreign trade operations, establishing the role of the economic system in the international division of labor.

In 2014, the largest share in the structure of shipped products of the extractive and manufacturing industries and engaged those engaged in the production and distribution of electricity, gas and water in the Kostroma region was held by jewelry manufacturing and furniture manufacturing (22.8 %), production, transmission

and distribution of electric power (21.3 %), manufacture of wood and of products of wood (16.2 %), which can be called the industries of specialization. The shares of other industries are significantly lower: metallurgical production and production of finished metal products (7.7 %), manufacture of vehicles and equipment (6.4 %), manufacture of food products, beverages and tobacco (6.4 %), production, transmission and distribution of steam and hot water (thermal power) (3.5 %), production of electrical, electronic and optical equipment (2.9 %) and manufacture of other non-metallic mineral products (2.6 %), manufacture of machinery and equipment (2.5 %), chemical manufacturing (2.0 %), and so on [19].

The dynamics of volumes of manufacturing in the Kostroma region (there was a 2.3 % decline in 2014) matches the overall Russian tendencies, with the fastest reduction rates observed for production of vehicles and equipment (32.1 %) and manufacture of machinery and equipment (26.4 %) (Tab. 1).

Note: the data from 2010 to 2012 is given taking into account the retrospective restatement of industrial production indices in connection with the transition to the new base in 2010.

Source: Industrial production in the Kostroma region, Statistical collection. Regional office of the Federal service of state statistics for the Kostroma region (Kostromastat), Kostroma, 2015, 294 p.

The following industries were in the lead in the structure of investmenst in manufacturing: manufacture of wood and of products of wood and metallurgical production and finished metal products (Figure). The share of production of machinery and equipment, production of electric, electronic and optical equipment, transport vehicles and equipment in the period under review was lower on average.

Table 1

Indices of manufacturing production in the Kostroma region, as a percentage (or by times, where so indicated) with respect to the previous year

Manufacturing	1995	2000	2005	2010	2011	2012	2013	2014
Manufacturing, including:	83.2	116.4	112.0	120.5	109.4	104.2	106.1	97.7
manufacture of food products, beverages and tobacco	75.4	107.4	110.8	100.7	92.0	113.3	92.0	96.2
textile and clothing manufacture	70.7	107.1	99.4	106.0	88.0	94.2	101.7	90.8
manufacture of leather, products from leather and footwear	84.8	100.1	110.1	100.9	75.0	111.0	127.1	106.9
wood processing and manufacturing products of wood	106.9	108.4	127.8	115.9	108.8	103.6	103.5	102.9
pulp and paper production; publishing and printing	89.2	99.3	89.6	100.5	135.0	125.9	108.5	95.2
chemical production	72.5	120.5	97.7	73.0	117.7	74.0	123.0	99.3
manufacture of rubber and plastic products	131.4	by 2.3	149.1	116.5	117.4	101.4	118.9	119.5
manufacture of other non-metallic mineral products	75.0	92.2	103.4	125.7	114.4	102.0	111.1	114.8
metallurgic production and production of finished metal products	83.4	by 2.5	99.8	115.5	103.9	84.8	101.7	96.2
manufacture of machinery and equipment	79.0	110.3	114.5	by 1.8	90.0	119.0	107.6	73.6
manufacture of electrical, electronic and optical equipment	94.2	136.1	145.6	125.8	124.2	105.0	115.2	118.4
production of vehicles and equipment	114.2	99.2	108.3	135.6	130.7	107.9	105.9	67.9
miscellaneous manufacturing	83.1	110.3	107.9	133.2	114.5	106.3	110.8	106.4
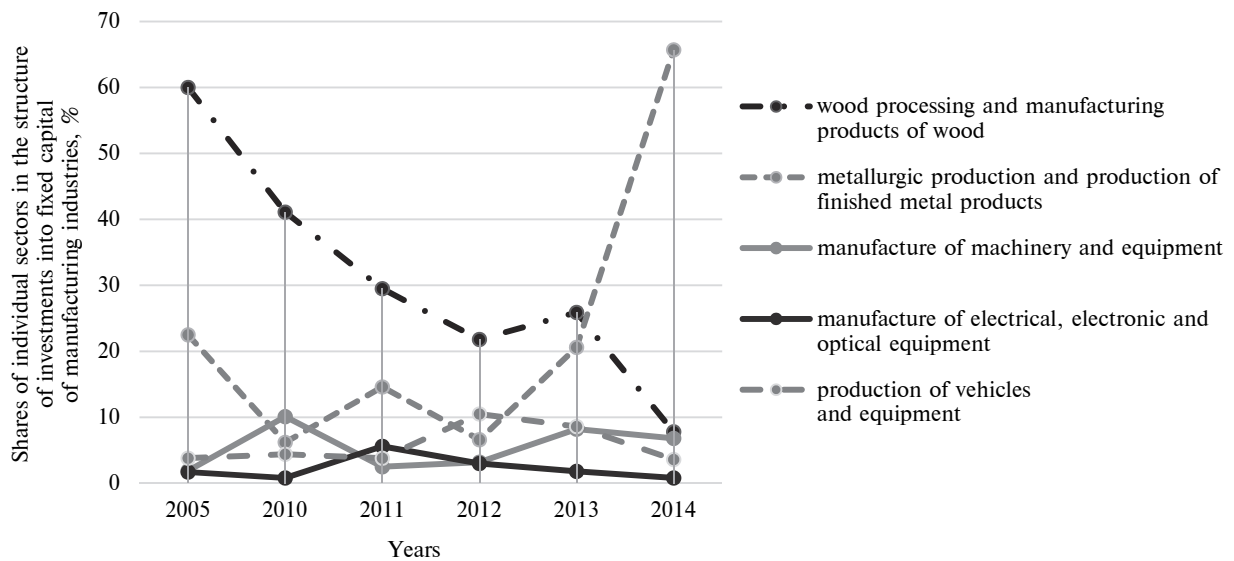
Dynamics of the share of individual sectors in the structure of investments into fixed capital of manufacturing in the Kostroma region, %

S o u r c e : compiled by the author based on the data from Industrial production in the Kostroma region, Statisticalcollection, Regional office of the Federal service of state statistics for the Kostroma region (Kostromastat), Kostroma, 2015, 294 p.

The foreign investments into the economy of the Kostroma region in the period under review were predominantly into manufacturing: 85.2 % in 2011 and 68.6 % in 2012, 99.97 % in 2013 [6]. of the leading industries benefiting from foreign investments in manufacturing in 2000, 2005, 2011, 2012, 2013 were the manufacturing of wood and of products of wood (73.8 %, 97.6, 91.0, 93.4, 77.8 %, respectively). The main volume of foreign investments in 2010 (85.4 %) was in the manufacturing of machinery and equipment, while it amounted to 17.9 % in 2013 [6].

The structure of foreign investments in the manufacturing enterprises of the Kostroma region corresponds to the commodity structure of its exports. The export commodity structure of the Kostroma region from 2010 to 2014 was dominated by wood pulp, paper and products: 67.7 %, 72.6, 80.9, 77.7, 85.3 % of the merchandise exports, respectively, and their share has been growing [4]. The shares of machinery, equipment and vehicles (10.8 %, 10.9, 7.0, 8.6, 5.5 %) decreased (Tab. 2).

T a b l e 2

Commodity structure of export of the Kostroma region, in % to the total

Export goods	2010	2011	2012	2013	2014
Total exports, including:	100	100	100	100	100
food products and agricultural raw materials (except textile)	0.6	0.5	0.5	0.2	0.1
chemical products, rubber and rubber products	1.5	1.2	1.3	1.1	1.5
wood and pulp and paper products	67.7	72.6	80.9	77.7	85.3
textiles and textile products	2.8	2.2	0.6	0.3	0.2
ferrous metals and products made of them	9.7	8.8	7.3	7.2	5.0
machinery, equipment and vehicles	10.8	10.9	7.0	8.6	5.5
other	2.9	2.1	0.8	2.2	2.4

S o u r c e : Foreign economic activity of organizations of the Kostroma region: Statistical collection, Regional office of the Federal service of state statistics for the Kostroma region (Kostromastat), Kostroma, 2015. 55 p.

The share of other commodity groups also decreased. In general, we can talk about the deterioration in the sectoral structure of industry and commodity structure of industrial exports in the Kostroma region. The manufacturing industry related to the exploitation of natural resources is developing, and the foreign investments intothis industry are involved in this exploitation, which generally reflects the nationwide problems of the structure of exports and foreign investments.

One of the most acute structural problems in the economy of the region and its industry is the low population density and the second largest area of territory in the Central Federal district with underdeveloped transport infrastructure and insufficient investments. The situation is exacerbated by the constantly decreasing population of the region. The proximity of the Kostroma region to such industrial centers as Moscow and Moscow oblast, and Yaroslavl contributes to the outflow of the most mobile labor from the region. The decisive factors for young people are higher wages, more attractive career opportunities and education. Many applicants with high exam scores prefer to leave to study in Moscow, Yaroslavl, or Saint Petersburg, because there more opportunities to get a budget place at a university and then get a job. Thus, the region annually loses a significant share of the most promising young people who could play a positive role in its development.

A complex of measures concerning the processes of education, investment, innovation, production is necessary in order to stop the outflow of workforce from the region. It would be justified to increase the number of budget places in educational institutions of the region, providing its organizations with qualified human resources, including industrial enterprises, with the prospect of future employment in the region. This requires improving the quality of strategic planning, the coordination of the processes of investment planning and the creation and development of enterprises, innovation, training of qualified human resources. Only state investments can play a leading role in the investment process and the creation of new jobs in the current economic crisis. The scientific, expert, project and educational activities of the Kostroma State University as the regional educational center can help improve the structure of the innovation process and the process of education with the appropriate government support and in active cooperation with the federal and municipal authorities, the business community and the public domain.

Solving structural problems requires the development and continuous improvement of methodological and procedural bases for estimating the efficiency of managing the structural changes in the economy (including regional) and industry in particular.

Principles of managing the structural changes in the economy (industry)

Principles of managing the structural changes in the economy (economic systems) with respect to the system approach should, from the point of view of the author, on the one hand, conform to the general principles of management (scientificity; systematicity and integrity; purposefulness; proportionality; presence of feedback; efficiency; effectiveness, etc.), principles of implementing the specific managerial functions (planning, organization, control, coordination, etc.), and, on the other hand, to the principle of consistency as the core of system philosophy.

Livshits gives the following main provisions of the principle: the integrity of the systems; the interrelation of the system as a whole and its parts; the superiority of the whole over the parts; the hierarchical structure of the system; the interaction of any object in the system with many others; a comprehensive external environment and its impact on the studied system; the dynamism of the systems, their structure, characteristics of elements; the ambiguity of the potential future state and behavior, including the often chaotic external environment of the studied systems; stability and/or effective adaptation, including the homeostatic behavior of complex systems in relation to the unknown; orientation toward the high efficiency of the systems performing their functions, taking into account all the major effects, i.e., internal, external and interactions [12].

Proceeding from the fundamental provisions of the principle of consistency and the general principles of management the author identifies the following principles of managing the structural changes in the economy (industry): 1) *the scientific principle*, implying that the

economy (industry) should be considered as an economic system; 2) *the principle of the complexity of the structure*, according to which the economic system has an inherently holistic nature, the whole and its parts are interconnected, the whole is superior over the parts, the system structure is hierarchical, any object in the system interacts with many others; 3) *the principle of taking into account the external environment* as a set of interacting economic systems of different types, properties, and functional; 4) *the principle of dynamism* of systems and their structure (given the ambiguity possible in the future state and behavior of the system); 5) *the principle of the systems fully accomplishing their functions* (each system has a set of functions in relation to the super-system); 6) *the principle of purposefulness* (the management of structural change should focus on achieving certain goals); 7) *the principle of adequate and timely response of the control system* to changes in the managed system; 8) *principle of effectiveness* (management aimed at achieving concrete results); 9) *the principle of efficiency* (the choice of those methods and management tools where planned results are achieved at the least cost).

The purpose of managing the structural changes in the economy (industry): criteria for selecting the management purpose

Based on the principle of consistency, the author formulates a definition for the purpose of managing the structural changes in the economy and the criteria for selecting this purpose. The purposes of managing the structural changes in the economy (industry) may include be the desired state of the economic system which corresponds to a certain structure, certain directions and pace of change, a certain set of sufficiently accomplished functions, some relations between subsystems and elements of the system, a certain character of response to the environment, a certain degree of stability, performance, efficiency of economic system.

The criteria for selecting the purpose of managing the structural changes in the economy should be: 1) the adequacy of the purposes to the essence (the objective) of the economic system; 2) compliance of the purpose with the current and desired level of development of the economic system; 3) compliance with the

condition of the external environment in which the economic system is functioning; 4) compliance with the time period in which the structural changes are supposed to be implemented; 5) the attainability of the goal (adequacy of financial, administrative, labor and other resources to achieve this goal); 6) compliance with the requirements of sufficient functionality (sufficient degree of achieving the functions of the economic system and its subsystems; 7) compliance with the requirements of stability, performance and efficiency of functioning of economic systems subject to structural changes.

Methods and tools for managing the structural changes in the economy (industry): criteria for choosing the methods and management tools

Based on the principles of purposefulness, efficiency and effectiveness of managing the structural changes in the economy, from the point of view of the author, it is possible to allocate the following criteria of choosing the methods and management tools: 1) the suitability of the selected methods and tools for the management objectives, the current and desired state (structure) of the economic system, the current and projected state of the environment that is external to the economic system; 2) the availability of adequate and quality institutional and methodological support for using appropriate techniques and management tools; 3) the efficiency of the appropriate methods and management tools; 4) the sufficiency of resources (financial, administrative, labor, etc.) for using the appropriate methods and management tools.

The subjects of managing the structural changes in the economy (industry)

Because structural changes occur in economic systems of different types (objects, projects, processes, environments), the approach to managing them must be integrated. The group of entities governing the structural changes should include entities that implement different economic policies: structural, financial (including monetary, monetary, fiscal, investment, industrial, etc. The operation of a group of control subjects implies the presence of a coordinating body. Thus, the first requirement

to the subjects of managing the structural change is a comprehensive approach.

The next requirement is a requirement to the level and quality of education of specialists and managers in state administration bodies responsible for planning, organizing, accounting, analyzing and controlling the structural changes in the corresponding economic system.

Principles, criteria and system of indicators to measure the quality of structural changes in the economy (industry)

Because structural changes can be analyzed and evaluated as a process and as a project, each of these subjects of structural changes will to different principles of assessment. In our opinion, the principles of evaluating investment projects are applicable to assessing structural changes as a project [3]. Some of these principles are applicable to assessing the process of structural changes. In particular, the methodological principles for assessing structural changes include: consistency, comprehensiveness, adequacy; methodological principles: comparison of situations with and without changes; uniqueness; measurability; the uncontrollability of the past; dynamic; incomplete information; operational principles: relationship between the parameters; multistage assessment; modeling; information consistency; methodological coherence; simplification; interconnection with government policy. Principles for assessing the structural changes of a project, in addition to the above, must include: public acceptability; payment for resources; nonnegative and maximum effect; profitability; presence of different project participants and coordination of their interests; organizational and economic mechanism of implementing the project, etc.

Let us formulate the criteria for evaluating the quality of structural changes in the economy. Structural changes occur in the managed and management systems in different types of economic systems, individual subsystems, between subsystems; may reflect evolutionary processes and processes of management; changes in the analyzed system and in the environment; characterize the integrity of the systems and the quality of the relationships between parts and the whole, the hierarchy of the system structure, the quality of interaction of any object in the system with many others; stability of the economic system, its capacity for adaptation and survival, the effectiveness of its functioning.

Thus, we can identify different *criteria* of analysis and assessment of structural changes: *temporal, spatial, conceptual, the criterion of communication and interaction,* as well as *evaluation criteria: sustainability, adaptation and efficiency*. Structural changes occur over time (with different frequency (intensity) and depth of the changes) in different points (areas) of economic space, for different reasons: in the course of evolution or under the influence of the control subject (that is, have a different nature). The structural changes taking place in the past and present, in different systems and subsystems influence each other, giving rise to regular structural changes. Structural changes (quantity, length in time and space) can serve as parameters of the analyzed economic system and elements for evaluating its stability, adaptability and survival, the efficiency of its functioning. It is important to assess the directions of structural change: whether the totality of the changes represents scientific and technological progress, socio-economic development, or, conversely, regress and degradation. It is also important to assess the impact of structural changes on accomplishing the functions of the economic system and its subsystems: whether it leads to an increase or decrease of dysfunctionality. The intensity of structural changes and whether it leads to dysfunctions of management (planning, organization, coordination, control) is of great importance. Additionally, it is important to assess the impact of structural changes on the stability of the economic system, its adaptability and efficiency of its functioning.

The author proposes a *system of indicators to measure the quality of structural changes in the economy (industry)*. The structural changes in industry as a set of *object* systems can be evaluated with the following set of indicators: evolution of the share of output of manufacturing industries, high-tech industries, import substitution industries, export-oriented industries in the production structure of the industrial complex, %; the structural dynamics of economic entities in the industrial complex (including in comparison with other complexes, and other regions); structural dynamics of employees of the economic complex, its

individual sectors (including in comparison with other complexes, and other regions); changes in the structure of average annual number of employees by types of economic activity (including changes in the share of manufacturing, mining); relationship dynamics of the average nominal wage in the industrial sector (individual sectors) to the average monthly nominal wage in the region, the average monthly nominal wage in other industrial complexes (industries), other regions, etc.; dynamics of commodity composition of exports of the industrial complex, dynamics of the specific weight of exports of separate kinds of production in their industrial production; dynamics of the share of imported raw materials, materials, components, machines, equipment consumption of the industrial complex; dynamics of indicators of profitability for individual businesses, some of the most important system types of products, individual sectors (in comparison with other business entities, products, sectors); indices of manufacturing production, in percent with respect to the previous year; dynamics of indexes of production of individual industries, the most important products (with a significant share in the production structure of the complex or strategically important for the supersystem), etc.

The structural changes in industry as a set of *project* systems can be evaluated with the following set of indicators: dynamics of sectoral structure of investment projects in the industry; dynamics of investments (domestic, foreign; direct, portfolio, other); structural dynamics of foreign investments by type; dynamics of the sectoral structure of funding of state programs in the industry, dynamics of indicators of efficiency of investment projects and state programs in the industry (compared with other regions), etc.

The quality of the structural changes in industry as a set of *process* systems (investment process, innovative process, process of privatization, etc.) can be assessed through a set of the following indicators: index of physical volume of investments into fixed capital in the industrial complex, % with respect to the previous year, in comparison with other industrial complexes (including in other regions); dynamics of the share of industry in the structure of investments in fixed capital in the region; structural dynamics of fixed capital investments in the industry; dynamics of structure of foreign

investments in the region's economy by type of economic activity, including industry; dynamics of the structure of foreign investments in manufacturing; structural dynamics of innovation in industry (selected industries), in comparison with innovation in the industry of other regions; dynamics of the share of innovative production in the total output of the industrial complex (separate branches), in comparison with other regions; dynamics of the specific weight of industry organizations involved in innovations in the total volume of industrial organizations; structural dynamics of the privatization process (change in the structure of the average annual number of employees in industry by type of ownership), etc.

Quality assessment of the structural changes of *the environmental systems* that affect the state and dynamics of the industrial complex involves: a qualitative analysis of changes in legislation; analysis of changes in the external environment: economic conditions (economic growth), the terms of credit (interest rates), inflation, etc.

Principles, criteria and system of indicators for assessing the efficiency of managing the structural changes in the economy (industry)

Principles of estimating the efficiency of managing the structural change in the economy (industry) comply with the general principles for assessing the efficiency of investment projects [3]. The author offers criteria and a system of indicators for estimating the efficiency of managing the structural changes. It should be noted that the criteria of the performance of the controlled and controlling subsystems have their own specifics, and therefore, their effectiveness should be reflected by different sets of indicators. The controlled system here indicates a system whose governance has undergone structural changes (Tab. 3). It is known that common approaches to the performance criteria of the control subsystem are: the effectiveness of management decisions, achievement of objectives, efficiency, the quality of the results. The degree of achievement of management objectives can be expressed using the ratio of actual and planned values of target indicators. Objectives, methodology, methods and management tools can completely or partially match the purpose or be unfit for it at all. Control functions may also be implemented

Table 3

Methods for assessing the effectiveness of implementing structural changes: criteria and indicators (controlled subsystem)

Criteria	Indicators
System expansion, sustainable growth, development	The production index of the economic complex (in comparable prices), % with respect to the previous year; the production indices of individual industries, the most important products (with a significant share in the production structure of the complex or strategically important for the meta-system)
Compliance of actual tendencies of system functioning and structural dynamics with requirements of self-preservation, stability, development	Share (and its dynamics) of the output of manufacturing industries, high-tech industries, industries of import substitution in the production structure of the corresponding complex, %; the index of physical volume of investments into fixed capital in the economic interest of the previous year, in comparison with other business systems (including in other regions); the number and dynamics of economic entities in the economic complex, their structure and structural dynamics (including in comparison with other complexes, and other regions); dynamics of the average number of employees of the economic complex, its individual sectors (including in comparison with other complexes, and other regions); the average monthly nominal wage in the economic complex, rub., etc.
Ratio of the performance of the system to the costs of its operation	Profitability for individual businesses in some of the most important types of products for the system, individual sectors (in comparison with other business entities, products, sectors); budget efficiency
Complete execution of system functions with respect to the meta-system	The following should be assessed for businesses (industry clusters): the completeness of accomplishing the functions of providing the population with jobs, income, food consumption; other enterprises with raw materials, materials, components (in cooperation), machinery and equipment, i.e., the indicators of consumption, production chains, import substitution, unemployment, etc.: unemployment rate (region, city, etc.), share of industry (sector) in total employment in the region (city), share of products (complex, industries, enterprises) in the production of such products in the country, in the consumption of its population (country, region, city, town), share of domestic production in consumption, share of domestic raw materials, materials, components, machinery and equipment in purchases of businesses, etc.

S o u r c e : compiled by the author.

fully, partially or not at all. In our opinion, the following are the most important for the controlled subsystem: 1) indicators of its viability (ability to continue operating for the foreseeable future): system expansion, sustainable growth and development; the actual tendencies of the system functioning and its structural dynamics meeting the requirements of self-preservation, stability, development; the ratio of the performance of the system to the costs of its operation; complete execution of system functions with respect to the meta-system.

The author suggests a system of criteria and indicators for evaluating the effectiveness of implementing the structural changes for administering the system. The criteria (and indicators) include: the degree of achieving management objectives (the ratio of achieved results to the number planned); consistency of the goals with the tasks, methodology, methods and management tools (tasks, methods and management tools can either fully (1) meet the set goals, meet them in part: mostly, by half, to a lesser extent (0.75; 0.5; 0.25), or not at all (0)); the ratio of the cost of implementing the structural changes with the degree of achieving the objectives (1st option of assessment: the ratio of the share of the results achieved to the amount of funds spent on implementing the structural changes; 2nd option of assessment (more accurate and reasonable): the ratio of results (volume of production in rubles) obtained through using budgetary funds actually allocated for implementing the structural changes to the amount of budget funds used); the extent to which the management functions are accomplished in relation to the managing meta-system and the managed system (the indicators

measuring the number, depth and frequency (in time and space) [24] of management dysfunctions: planning, organization, coordination, etc., for example, the proportion of disrupted functions in their total amount (from a certain set), the share of dysfunctional subsystems (elements) in the total number of subsystems (elements), etc.).

The results of the study:

1. The article gives a brief analysis of the industry in the Kostroma region as an object of managing structural changes. The study identifies the deterioration trends in the sectoral structure of industry, the commodity structure of industrial exports and other structural problems of the economy of the Kostroma region. The author offers measures aimed at solving certain structural problems in the economy and industry of the region.

2. On the basis of the principle of consistency as a core of system philosophy, and general principles of management, the author formulated the principles of managing the structural changes in the economy (industry). The author justified the selection criteria of the purpose, the methods, and the tools to manage the structural changes in the economy (industry).

3. The author developed the criteria for assessing the quality of structural changes in the economy (industry). The author proposed a system of indicators to assess structural changes in the economy (industry) as a set of object, project and process systems, and to assess

structural changes in environmental systems that affect the state and trends of the industry.

4. The author has developed criteria and a system of indicators for estimating the efficiency of managing the structural changes in the economy (industry) for the controlled and controlling systems.

5. The methodology and procedure for assessing the quality and effectiveness of managing the structural changes in the economy should ensure that the goals of the state development programs are achieved and improve the efficiency of state management of the economy of the region. Continuous monitoring of the structural changes in the economy of the region and its industry will allow to timely indicate the structural problems and their aggravation, and to direct the available resources to resolve these problems. The proposed methodology and procedure will provide a systematic management of the structural changes in the economy and industry of the region. The scope of application of the obtained results is the structural policy, the management of structural changes in national and regional economy, economic complexes, industry.

The author sees the **directions for further research** in developing a more expanded system of indicators for assessing the efficiency of structural changes, in substantiating the criteria for the goals set matching the task, methodology, methods and tools for managing structural changes, the criteria and indicators of completeness of implementing the functions of the economic systems with respect to the meta-systems.

REFERENCES

1. **Anchishkin A.I., Iaremenko Iu.V.** Tempy i proportsii ekonomicheskogo razvitiia. M.: Ekonomika, 1967. (rus)

2. **Bodrunov S.D.** Formirovanie strategii reindustrializatsii Rossii : monogr. V 2 ch. Ch. 1. 2-e izd. SPb.: INIR, 2015. 551 s. (rus)

3. **Vilenskii P.L., Livshits V.N., Smoliak S.A.** Otsenka effektivnosti investitsionnykh proektov: Teoriia i praktika: ucheb. posobie. 5-e izd. M.: Poli Print Servis, 2015. 1300 s. (rus)

4. Vneshneekonomicheskaia deiatel'nost' organizatsii Kostromskoi oblasti: stat. sb. Kostroma: Kostromastat, 2015. 55 s. (rus)

5. **Grinberg R.S.** Svoboda i spravedlivost'. Rossiiskie soblazny lozhnogo vybora. M.: Magistr : Infra-M, 2012. 416 s. (rus)

6. Investitsionnaia i stroitel'naia deiatel'nost' v Kostromskoi oblasti: stat. sb. Kostroma: Kostromastat, 2014. 116 s. (rus)

7. **Kantorovich L.V., Plisko V.E.** Sistemnyi podkhod v metodologii matematiki. *Sistemnye issledovaniia. Metodologicheskie problemy* (ezhegodnik): sb stat. 1983. Vyp. 15. S. 27−41. (rus)

8. **Kleiner G.B.** Evoliutsiia institutsional'nykh sistem; TsEMI RAN. M.: Nauka, 2004. 240 s. (rus)

9. **Kleiner G.B.** Sistemnaia ekonomika kak platforma razvitiia sovremennoi ekonomicheskoi teorii. *Voprosy ekonomiki.* 2013. № 6. S. 4−28. (rus)

10. **Kleiner G.B.** Ekonomika. Modelirovanie. Matematika: izbrannye trudy. Rossiiskaia akademiia nauk, Tsentral'nyi ekonomiko-matematicheskii institut. M.: TsEMI RAN, 2016. 856 s. (rus)

11. **Livshits V.N.** O Metodologii otsenki effektivnosti rossiiskikh investitsionnykh proektov: nauch. doklad. M.: In-t ekonomiki RAN, 2009. 70 s. (rus)

12. **Livshits V.N.** Sistemnyi analiz rynochnogo reformirovaniia nestatsionarnoi ekonomiki Rossii: 1992−2013. M.: LENAND, 2013. S. 62. (rus)

13. **L'vov D.S.** Kontseptsiia upravleniia natsional'nym imushchestvom. M.: INES, 2002. 36 s. (rus)

14. L'vov D.S. Sistema natsional'nogo dividenda − planetarnaia model' XXI veka. *Sankt-Peterburgskii ekonomicheskii forum: V vstrecha na beregakh Nevy.* M.: Otd-nie ekonomiki RAN. Torgovo-promyshlennaia palata RF, 2001. 20 s. (rus)

15. **L'vov D.S.** Ekonomicheskii rost i kachestvo ekonomiki. M.: Russkaia kniga, 2004. 112 s. (rus)

16. Mezoekonomika razvitiia. Pod red. chl.-korr. RAN G.B. Kleinera; TsEMI RAN. M.: Nauka, 2011. 805 s. (rus)

17. Metody planirovaniia mezhotraslevykh proportsii. Pod red. A.N. Efimova, L.Ia. Berri. M.: Ekonomika, 1965. (Nauchno-issledovatel'skii ekonomicheskii in-t Gosplana SSSR). 351 s. (rus)

18. **Prangishvili I.V.** Sistemnyi podkhod i obshchesistemnye zakonomernosti. M.: SINTEG, 2000. 528 s. (Sistemy i problemy upravleniia). (rus)

19. Promyshlennoe proizvodstvo v Kostromskoi oblasti: stat. sb. Kostroma: Kostromastat, 2015. 294 s. (rus)

20. **Sukharev O.S.** Teoriia disfunktsii ekonomicheskikh sistem i institutov. M.: LENAND, 2014. 144 s. (rus)

21. **Sukharev O.S.** Teoriia effektivnosti ekonomiki: monografiia. M.: KURS: Infra-M, 2014. 368 s. (rus)

22. **Sukharev O.S.** Structural Modelling of Economic Growth: Technological changes. *Megatrend Review*, 2016, vol. 13, no. 1.

23. **Sukharev O.S.** Theory of economic changes: problems and decisions. Moscow, KRASAND. 2013. 386 p.

24. **Sukharev O.S., Palash S.V.** Disfunktsii ekonomicheskikh sistem i upravleniia. M.: LENAND, 2016. 304 s. (rus)

25. **Shreider Iu.A.** K postroeniiu iazyka opisaniia system. Sistemnye issledovaniia (ezhegodnik): sb stat. 1973. M.: Nauka, 1973. S. 226. (rus)

26. **Iaremenko Iu.V.** Prioritety strukturnoi politiki i opyt reform. M.: Nauka, 1999. (rus)

27. **Palash S.V.** Strukturnye disproportsii i disfunktsii ekonomicheskikh sistem. URL: http://inecon.org/docs/Palash_paper_20160126.pdf (data obrashcheniia: 26.01.2016). (rus)

28. Portal gosprogramm RF. URL: http://programs.gov.ru/Portal/ (data obrashcheniia: 15.08.2016). (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Анчишкин А.И., Яременко Ю.В.** Темпы и пропорции экономического развития. М.: Экономика, 1967.

2. **Бодрунов С.Д.** Формирование стратегии реиндустриализации России : моногр. В 2 ч. Ч. 1. 2-е изд. СПб.: ИНИР, 2015. 551 с.

3. **Виленский П.Л., Лившиц В.Н., Смоляк С.А.** Оценка эффективности инвестиционных проектов: Теория и практика: учеб. пособие. 5-е изд. М.: Поли Принт Сервис, 2015. 1300 с.

4. Внешнеэкономическая деятельность организаций Костромской области: стат. сб. Кострома: Костромастат, 2015. 55 с.

5. **Гринберг Р.С.** Свобода и справедливость. Российские соблазны ложного выбора. М.: Магистр : Инфра-М, 2012. 416 с.

6. Инвестиционная и строительная деятельность в Костромской области: стат. сб. Кострома: Костромастат, 2014. 116 с.

7. **Канторович Л.В., Плиско В.Е.** Системный подход в методологии математики // Системные исследования. Методологические проблемы (ежегодник): сб стат. 1983. Вып. 15. С. 27−41.

8. **Клейнер Г.Б.** Эволюция институциональных систем; ЦЭМИ РАН. М.: Наука, 2004. 240 с.

9. **Клейнер Г.Б.** Системная экономика как платформа развития современной экономической теории // Вопросы экономики. 2013. № 6. С. 4−28.

10. **Клейнер Г.Б.** Экономика. Моделирование. Математика: избранные труды / Российская академия наук, Центральный экономико-математический институт. М.: ЦЭМИ РАН, 2016. 856 с.

11. **Лившиц В.Н.** О Методологии оценки эффективности российских инвестиционных проектов: науч. доклад. М.: Ин-т экономики РАН, 2009. 70 с.

12. **Лившиц В.Н.** Системный анализ рыночного реформирования нестационарной экономики России: 1992−2013. М.: ЛЕНАНД, 2013. С. 62.

13. **Львов Д.С.** Концепция управления национальным имуществом. М.: ИНЭС, 2002. 36 с.

14. **Львов Д.С.** Система национального дивиденда − планетарная модель XXI века // Санкт-Петербургский экономический форум: V встреча на берегах Невы. М.: Отд-ние экономики РАН. Торгово-промышленная палата РФ, 2001. 20 с.

15. **Львов Д.С.** Экономический рост и качество экономики. М.: Русская книга, 2004. 112 с.

16. Мезоэкономика развития / под ред. чл.-корр. РАН Г.Б. Клейнера; ЦЭМИ РАН. М.: Наука, 2011. 805 с.

17. Методы планирования межотраслевых пропорций / под ред. А.Н. Ефимова, Л.Я. Берри. М.: Экономика, 1965. (Научно-исследовательский экономический ин-т Госплана СССР). 351 с.

18. **Прангишвили И.В.** Системный подход и общесистемные закономерности. М.: СИНТЕГ, 2000. 528 с. (Системы и проблемы управления).

19. Промышленное производство в Костромской области: стат. сб. Кострома: Костромастат, 2015. 294 с.

20. **Сухарев О.С.** Теория дисфункции экономических систем и институтов. М.: ЛЕНАНД, 2014. 144 с.

21. **Сухарев О.С.** Теория эффективности экономики: монография. М.: КУРС: Инфра-М, 2014. 368 с.

22. **Sukharev O.S.** Structural Modelling of Economic Growth: Technological changes // Megatrend Review, 2016, vol. 13, no. 1.

23. **Sukharev O.S.** Theory of economic changes: problems and decisions. Moscow, KRASAND. 2013. 386 p.

24. **Сухарев О.С., Палаш С.В.** Дисфункции экономических систем и управления. М.: ЛЕНАНД, 2016. 304 с.

25. **Шрейдер Ю.А.** К построению языка описания систем // Системные исследования (ежегодник): сб стат. 1973. М.: Наука, 1973. С. 226.

26. **Яременко Ю.В.** Приоритеты структурной политики и опыт реформ. М.: Наука, 1999.

27. **Палаш С.В.** Структурные диспропорции и дисфункции экономических систем. URL: http://inecon.org/docs/Palash_paper_20160126.pdf (дата обращения: 26.01.2016).

28. Портал госпрограмм РФ. URL: http://programs.gov.ru/Portal/ (дата обращения: 15.08.2016).

PALASH Svetlana V. − Kostroma State University.
156005. Dzerzhinsky str. 17. Kostroma. Russia. E-mail: svpalash@yandex.ru

ПАЛАШ Светлана Витальевна − заведующий кафедрой Костромского государственного университета, кандидат экономических наук.
156005, ул. Дзержинского, д. 17, г. Кострома, Россия. E-mail: svpalash@yandex.ru

A.V. Babkin, Yu.V. Vertakova, V.A. Plotnikov

ASSESSING THE ECONOMIC EFFICIENCY OF CLUSTER FUNCTIONING: A QUANTITATIVE APPROACH

А.В. Бабкин, Ю.В. Вертакова, В.А. Плотников

ОЦЕНКА ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ ФУНКЦИОНИРОВАНИЯ КЛАСТЕРОВ: КОЛИЧЕСТВЕННЫЙ ПОДХОД

The cluster approach, i.e., forming basic innovative and industrial clusters has gained wide circulation in modern Russian conditions for the development of the economy. These actions are considered by federal and regional authorities as effective measures for implementing the economic policy stimulating regional development. The analysis we carried out showed that the quantitative approach for assessing the efficiency of cluster creation and performance is still insufficiently used. In this paper we establish and quantitatively estimate the influence cluster have on the regional economy using regression analysis with an example of a number of Russian regional clusters. It is offered to expand the practice of creation and the state support of clusters taking into account the revealed quantitative dependences estimating their efficiency. We have advanced the hypothesis that clustering has a positive influence on regional economy, and confirmed this influence by means of quantitative methods using representative datasets. Our study of course had a selective character as it is not possible to carry out calculations for all existing clusters and cluster initiatives of Russia and discuss the results within a single article. At the same time, following the analysis we performed, we concluded that it is effective to initiate cluster creation in Russian regions. It is shown that cluster activity is capable to have of having a positive impact on GRP growth and the budgetary income in the region. Along with that, we note the dissimilarities in the multiplying influence of clusters on the regional development, its dependence on territorial and branch specifics that will be the direction for a further in-depth study.

CLUSTER POLICY; CLUSTER; EFFICIENCY ASSESSMENT; REGIONAL ECONOMY; REGIONAL DEVELOPMENT.

В современных российских условиях широкое распространение получил кластерный подход, заключающийся в формировании базовых инновационных и инновационно-промышленных кластеров. Эти действия рассматриваются федеральными и региональными органами государственного управления как эффективная мера реализации экономической политики, стимулирующая региональное развитие. Проведенный анализ показал, что при этом пока еще недостаточно используется количественный подход для оценки эффективности создания и функционирования кластеров. На примере ряда российских региональных кластеров с использованием метода регрессионного анализа выявлено и количественно оценено их влияние на региональную экономику. Предлагается расширить практику создания и государственной поддержки функционирования кластеров с учетом выявленных количественных зависимостей, оценивающих их эффективность. Выдвинутая гипотеза о наличии положительного влияния процессов кластеризации на экономику регионов в ходе исследований нашла количественное подтверждение. Причем, это влияние доказано при помощи количественных методов с использованием репрезентативных рядов данных. Исследование, безусловно, носит выборочный характер, так как провести расчеты по всем заявленным кластерам России и кластерным инициативам и обсудить их результаты в рамках одной статьи не представляется возможным. Сделан вывод об эффективности инициирования создания кластеров в регионах России. Показано, что их деятельность способна оказывать положительное влияние на рост ВРП и бюджетных доходов в регионе. Одновременно с этим отмечены неодинаковость мультиплицирующего влияния кластеров на региональное развитие, его зависимость от территориальных и отраслевых особенностей как направления дальнейшего углубленного исследования.

КЛАСТЕРНАЯ ПОЛИТИКА; КЛАСТЕР; ОЦЕНКА ЭФФЕКТИВНОСТИ; РЕГИОНАЛЬНАЯ ЭКОНОМИКА; РЕГИОНАЛЬНОЕ РАЗВИТИЕ.

Cluster initiatives are widely adopted in modern Russia. According to the Russian cluster observatory (http://map.cluster.hse.ru/list — the Map of Clusters of Russia project), now 99 organized clusters can be identified in the country. Other sources give slightly different

estimates on the quantity of clusters in the Russian Federation, but it isn't concrete numbers, and in qualitative result. Clusters became a noticeable phenomenon, especially at the regional level of the national economy. Because of this, many publications are dedicated to studying them [1, 3, 4, 7, 8, 11−15, etc.] (we should note that the authors of this article also made a certain contribution to studying these issues [2, 5, 6, 9, 10, etc.]).

While we do not intend to analyze cluster and the publications dedicated to them in detail, we should point out on circumstance that is important in our opinion: cluster organization of economic associations is confirmed to be rather effective both in theory and in practice. This article is dedicated to critical consideration of this statement. We will use methods of quantitative analysis for assessing the efficiency of cluster organization of economic activity.

We used the above-mentioned Map of clusters of Russia as basic data for carrying out calculations. Since it contains numerous objects and our computing and temporal resources were limited, we selected four clusters from the entire set (Tab. 1). We selected the clusters for study based on the premise that if some clusters existed in the same branch, preference was given to the cluster with a higher level of organizational development or functioning during a longer period. We also paid attention to the existence of necessary statistical information on clusters. Besides, when forming our selection, we strived to make it cover various non-related branches to obtain more objective results.

T a b l e 1

Selection of clusters for quantitative analysis

Cluster, region	Branch	Participants of cluster	Level of organizational development	Year of establishment
Textile cluster of the Ryazan Oblast	Production of textile products, clothes, footwear, leather products	Valentin Yudashkin, Kadomsky Veniz, Korablinsky Textile Factory, Corporation of Fevelopment of the Ryazan Oblast, National Investment and Finance Corporation, Skopinsky Clothing Factory, Truzhenitsa, Municipal Administration of the Korablinsky municipal area, the Ministry of economic development and trade of the Ryazan Oblast, Branch of the Ivanovo State Textile Academy in Ryazan, Agrotechnological Technical School (of Korablino)	Initial	2014
Power cluster of Tula region	Electricity generation and electric equipment	Quadra Power Generation, Transelektro, Tula City Electric Networks, Aleksinsky combined heat and power plant, Efremovskaya TPP (production division of Quadra Power Generation), Novomoskovsk state district power station (production division of Quadra Power Generation), Pervomayskaya combined heat and power plant (production division of Quadra Power Generation), Tulenergo Branch IDGC of Centre and Volga region, D.G. Zhimerin Cherepetskaya GRES Branch of Inter RAO Elektrogeneration joint-stock company, Shchyokinsky state district power station (production division of the Quadra Tula branch)	Initial	2012

Cluster, region	Branch	Participants of cluster	Level of organizational development	Year of establishment
Innovative territorial timber industry cluster Arkhangelsk region Pomorinnovales	Forestry and woodworking; pulp and paper production	Alliance Teplo Energo, Arkhangelsk Repair and Operational Base of Fleet, Arkhangelsk Sea Commercial Port, Arkhangelsk Plywood Plant, Roslesinforg, Arkhangelsk Pulp and Paper Mill, Arkhbioenergo, Arkhbum, Arkhgiprobum, Belomorskiy Les, Biolaboratory Farm, Timber Mill 25, Liszt, Niva, Novodvinsk Industrial Technical School, Nord-Wood, Nordtekhsad, Titan Group, Plesetsk Logging Enterprise, Pomor forest science and technology park, Priroda, Interstroy Production Company, Northern Shipping Company, Northern Research institute of forestry, Tekhnoservice, Trast, Office of the Federal Penitentiary Service of the Arkhangelsk Oblast, Gudkov, Korelsky and Smolyarzh Law Firm	Average	2014
Dairy cluster of the Vologda region	Agriculture and fishery	Union Stud Farm, Abiogroup, Agrokon-Vologda, Agrokorm, Agromolservice, Chushevitsa Agro-industrial complex, Agrotekhnika-Vologda, Anokhinsky SPK, Babushkinskoe Moloko, Kolkhoz Verny SPK, Vologdaburvodservice, Grinbiotekh-Agro, Zarya, Zoovetfarm-Region, C/A Kalinin Kolkhoz, KFH Krendelev R.L., Totemsky Butter Factory, Mechanikov A.A. Farm, Mekhanikov M.V. Farm, Myzin A.V. Farm, Myaksinsky Kolkhoz, Nizhne-Kuloye Kolkhoz SPK, Otkrity Mir Kormov, Mayskiy Stud Farm SPK, Cherepovetskoye Plempredpriyatiye, Vologodskoye Plemproizvoditel, Pokrovskoye, Prisukhonskoye SHPK, Protemol, Rus SPK, Kolkhoz Sever SPK, Simakina E.V. Farm., Spirina G.S. Farm, Tarnogsky Butter Farm, Vozhrozhdenie UK, Progress UK, Ferapontovo SPK, Sheksna, Sheksninskaya Zarya, Elitniye Semena	Initial	2015

S o u r c e : data of the Russian cluster observatory (http://map.cluster.hse.ru/list).

We considered the following resultant indicators: level of economic development of the region, which is estimated quantitatively through GRP per capita (thousands of rubles), as well as the income of the budget (the average per capita indicator measured in thousands of rubles per person per year was also considered). We estimated how these indicators changed under the influence of cluster initiatives introduced by the regions under consideration. Since the assessed clusters operate in various branches of specialization, we used similar indicators for quantitative assessment. These included the volume of investment and output, but considered not for the region as a whole but only for branches of cluster specialization (Figure). Thus, the average per capita estimates measured in thousands of rubles were also used.

23

Ryazan Oblast	Tula Oblast	Arkhangelsk Oblast	Vologda Oblast

GRP per capita (y_1)

Volume of shipped production "textile, sewing production, leather products and production of footwear" (x_1)	Volume of shipped production "production and distribution of electric power, gas and water" (x_1)	Volume of shipped production "pulp-and-paper production" (x_1)	Production of agricultural products (x_1)
Investments into fixed capital of processing production (x_2)	Investments into fixed capital of production, transfer and distribution of electric power, gas and water (x_2)	Investments into fixed capital of processing production (x_2)	Investments into fixed capital of agriculture, hunting and forestry (x_2)

Budget income (y_2)

Resultant and factorial indicators for the analysis of clusters

Information from statistical collections of Rosstat was used as basic data for calculations. The period from 2004 to 2014 was covered. The regression analysis method was used which allows to estimate the extent of mutual influence of the considered indicators with a sufficiently high degree of accuracy. Linear one- and two-factorial equations of regression were constructed, given in Tab. 2 (only the dependences which have a high degree of accuracy, estimated by the determination coefficient R^2, are presented in the table).

T a b l e 2

Regression dependences of indicators of analyzed clusters and regions

Oblast	Indicators	Regression equation	R^2
Ryazan Oblast	GRP per capita (y_1)	$y_1=21.488+13.45209x_2$ $y_1=17.385+5.776x_1+13.01x_2$	0.86 0.88
	Budget income (y_2)	$y_2=6.03933+2.03368x_2$ $y_2=5.829+0.296x_1+2.011x_2$	0.82 0.82
Tula Oblast	GRP per capita (y_1)	$y_1=11.89458+11.858x_1$ $y_1=85.95291+13.198x_2$ $y_1=15.441+8.267x_1+7.116x_2$	0.79 0.67 0.91
	Budget income (y_2)	$y_2=1.885+2.206x_1$ $y_2=16.144+2.376x_2$ $y_2=2.482+1.602x_1+1.197x_2$	0.76 0.63 0.89
Arkhangelsk Oblast	GRP per capita (y_1)	$y_1=95.97+5.906x_1$ $y_1=96.077+5.91x_1-0.03x_2$	0.62 0.62
	Budget income (y_2)	$y_2=15562+0.905x_1-0.401x_2$	0.62
Vologda Oblast	GRP per capita (y_1)	$y_1=-53.685+18.937x_1$ $y_1=54.295+87.771x_2$ $y_1=-49.738+16.812x_1+14.602x_2$	0.88 0.63 0.88
	Budget income (y_2)	$y_2=9.864+12.311x_2$ $y_2=-3.153+2103x_1+3.156x_2$	0.70 0.93

The analysis of the obtained dependences given in the table allows to draw conclusions as to the extent to which the growth of investments into fixed capital and production volumes influences the amount of the gross regional product and the budget income of the considered regions with clusters:

1. Ryazan Oblast (textile cluster):
− with the investments into the fixed capital of the processing industry increased by 1 thousand rub., the GRP increases by 16565 rub., i.e., the coefficient of a multiplication in this case exceeds 16.5;

− with the production volume for «textile, sewing production, leather products and production of footwear» increased by 1 thousand rub., the GRP will increase by 5776 rub. at the same volume of investment into fixed capital. The increase in the volume of investments into fixed capital of the processing industry by 1 thousand rub. at the same volume of production implies GRP growth by 13010 rub., i.e. the multiplying influence of investments on the GRP exceeds a similar influence of the output increase of the cluster's enterprises by more than two times. At the same time, the production in the cluster is observed to experience a fast growth by almost 5 times with respect to the overall GRP;

− with the volume of investments into fixed capital of the processing industry increased by 1 thousand rub., the income of the budget will increase by 20337 rub., i.e., the coefficient of multiplication in this case exceeds 20.3. It is obvious that granting benefits for the investment activity of textile enterprises is economically justified;

− with the production volume for «textile, sewing production, leather products skin and production of footwear» increased by 1 thousand rub., the income of the budget will increase by 296 rub. at the same volume of investments into fixed capital. The increase in the volume of investments into fixed capital of the processing industry by 1 thousand rub. at the same volume of production leads to the income of the budget increasing by 2011 rub.

Thus, the performance of the enterprises from the «textile, sewing production, leather products and production of footwear» cluster in the Ryazan Oblast has a considerable positive impact on the growth of the GRP and the income of the budget, and investments into fixed capital of the processing industry pay off, having a substantial positive impact on the growth of these indicators. Therefore, the creation of a textile cluster in the Ryazan Oblast was expedient; this cluster has a substantial positive multiplying impact on the regional economy. In this regard, it is possible to conclude that the textile cluster of the Ryazan Oblast is effective.

2. Tula Oblast (power cluster):
− with the production volume for «production and distribution of the electric power, gas and water» increased by 1 thousand rub., the GRP will increase by more than by 11 times, i.e., by 11858 rub.;

− with the investments into fixed capital of production, transfer and distribution of the electric power, gas and water increased by 1 thousand rub., the GRP will increase even more considerably by 13198 rub.;

− with the production volume for «production and distribution of the electric power, gas and water» increased by 1 thousand rub., the GRP will increase by 8267 rub at the same volume of investments into fixed capital. The increase in the volume of investment into the fixed capital of production, transfer and distribution of the electric power, gas and water by 1 thousand rub. at the same production volume leads to an increase of the GRP by 7116 rub;

− with the production volume for «production and distribution of the electric power, gas and water» increased by 1 thousand rub., the income of the budget will increase by 2206 rub;

− with the volume of investments into fixed capital for production, transfer and distribution of the electric power, gas and water increased by 1 thousand rub., the income of the budget will increase by 2376 rub;

− with the production volume for «production and distribution of the electric power, gas and water» increased by 1 thousand rub., the income of the budget will increase by 1602 rub at the same volume of investments into fixed capital. The increase in the volume of investments into the fixed capital for production, transfer and distribution of the electric power, gas and water by 1 thousand rub. at the same production volume leads to an increase of the income of the budget by 1197 rub.

Based on the obtained results, we can draw conclusions for the power cluster of the Tula Oblast similar to the above-formulated ones for the textile cluster of the Ryazan Oblast. Quantitative estimates of the cluster's impact on the indicators of the regional economy in the Tula Oblast are slightly lower than in the Ryazan Oblast. Nevertheless, the economic performance (investments and output) of the cluster's enterprises also has a positive multiplying impact on the regional economy. Quantitative distinctions which we found can be caused by territorial, industrial, technological, institutional and other factors; detailed analysis of these factors is outside the scope of this article.

3. Arkhangelsk Oblast (timber industry cluster):

− with the production volume of the pulp-and-paper industry increased by 1 thousand rub., the GRP will increase by 5906 rub. This means that this type of production is closely tied with the GRP, and the coefficient of multiplication is almost equal to 6 units;

− with the production volume of the pulp-and-paper industry increased by 1 thousand rub., the GRP will increase by 5910 rub. at the same volume of investments into fixed capital; the increase in the volume of investments into the fixed capital of the processing industry by 1 thousand rub. at the same volume of production will cause a reduction of the GRP by 0.03 thousand rubles. Though this reduction is insignificant (it is possible to explain it by statistical error), but it is still present and thus demands further study;

− with the production volume of the pulp-and-paper industry increased by 1 thousand rub., the income of the budget will increase by 905 rub. (a very significant increase which can indicate, firstly, the considerable multiplying influence of the pulp-and-paper industry on the economic activity in the Arkhangelsk Oblast, and, secondly, the raised tax burden of this branch) at the same volume of investment into fixed capital. With the volume of investment into fixed capital of the processing industry increased by 1 thousand rub. at the same volume of production, the income of the budget will be reduced by 401 rub. It is worth focusing on this last result: the mechanism of its formation is not quite clear. It then follows that

the growth of investment activity in the Arkhangelsk Oblast is undesirable from the positions of budget formation. It reduces the income of the budget. This result cannot be explained by calculation errors or inaccuracies of the basic data (as we did in the previous subparagraph): the ratio of investment growth to the decrease in the budgetary income equals 5:2 and is rather significant.

The obtained results testify that the performance of the timber industry cluster in the Arkhangelsk Oblast has a positive impact on the economy of the region, increasing the GRP and the income of the budget. However, investments into the fixed capital of the processing industry in this case are not effective as the increase in their volume leads to a reduction of both the GRP and the income of the budget. Thus, the Pomorinnovales innovative territorial timber industry cluster can be considered effective from positions of development of the regional economy, but a revision of the investment policy of the region, and improvement of its mechanisms are necessary.

4. Vologda Oblast (dairy cluster):

− with the production volume of the agricultural industry increased by 1 thousand rub., the GRP will increase by 18937 rub. In this case we recorded the greatest numerical value of the multiplier, 18.9. This means that the development of the agricultural industry (if we judge by the considered selection of clusters) has the greatest multiplying impact on the regional economy. We connect it with the circumstance that the creation of agroclusters means not only production, but also processing of the agricultural products in the territory of the region where the cluster is located, which in turn generates additional types of economic activity, additional workplaces and added value;

− with the volume of investments into the fixed capital of agriculture, hunting and forestry increased by 1 thousand rub., the GRP will increase by 87771 rub. This means that here we observe an even larger multiplying impact on the development of the regional economy than the one we considered in the previous subparagraph. This confirms the conclusion about the priority of state support of production and processing of agricultural products. The crux of the matter here is not in solving social (support of the rural

areas) or political (ensuring food security) tasks, but in purely economic reasons. This support generates a very high economic effect;

− with growth of volume of release of agricultural production increased by 1 thousand rub., GRP will increase for 16812 rub at the same volume of investment into fixed capital. The increase in the volume of investment into fixed capital of agriculture, hunting and forestry increased by 1 thousand rub., at the same volume of production, will cause increase of GRP on 14602 thousand rubles. Thus, and at joint increase in two influencing factors considered by us, the resultant variable shows very high sensitivity;

− with the volume of investments into the fixed capital of agriculture, hunting and forestry increased by 1 thousand rub., the income of the budget will increase by 12311 rub. This circumstance seems very important to us. It is an additional argument for state support (including within the existing institutional regulations and financial) of agrocluster development;

− with the volume of agricultural production increased by 1 thousand rub., the income of the budget will increase by 2013 rub at the same volume of investments into fixed capital. The volume of investments into the fixed capital of agriculture, hunting and forestry increased by 1 thousand rub. at the same volume of production will cause an increase of the income of the budget by 3156 thousand rubles.

Thus, calculations showed that the performance of the agricultural enterprises in the Vologda Oblast and investments into the working capital of agriculture, hunting and forestry have a very significant positive impact on the growth of the GRP and the income of the budget. It follows from this that the dairy cluster created in the region functions in an effective specialization branch, and the full support of its development is necessary and economically expedient.

Conclusions. Summing up the results, we will note that the hypothesis we advanced about the positive influence that clustering has on the regional economy was confirmed quantitatively. This influence was proved by means of quantitative methods using enough representative datasets (covering 11 years). Our study undoubtedly had a selective character: it does not seem possible to carry out calculations for all cluster initiatives existing in Russia and to discuss their results within a single article. At the same time, following the results of the analysis we carried out, it is possible to draw a conclusion on the efficiency of creating clusters in Russian regions. Cluster activity is capable of having a positive impact on the growth of GRP and the budgetary income in the region. Along with it, we noticed differences in the multiplying influence of clusters on regional development, and its dependence on territorial and branch specifics. Apparently, this question requires further in-depth study.

REFERENCES

1. **Arkin P.A., Golubev A.G.** Structurization of innovative process in a cluster: information and logistic method. *News of the St. Petersburg state economic university*, 2014, no. 1, pp. 58−62. (rus)

2. **Babkin A.V., Novikov A.O.** Cluster as a subject of economy: essence, current state, development. *St. Petersburg State Polytechnical University Journal. Economics*, 2016, no. 1(235), pp. 9−29. DOI: 10.5862/JE.235.1 (rus)

3. **Badgers D.P., Kudryashov V.S.** Formation of an industrial cluster: theoretical and methodical aspects: monograph. St. Petersburg, 2014. (rus)

4. **Borodkina E.V., Risin I.E.** Public administration by processes of a clustering of social and economic space of the region: monograph. Voronezh, Publishing house of VGPU, 2011. 159 p. (rus)

5. **Vertakova Yu.V., Plotnikov V.A.** Tipologization's Carpenters of approaches to formation and development of propulsive clusters in region economy. *Economy and management*, 2016, no. 3(125), pp. 10−18. (rus)

6. **Vertakova Yu.V., Polozhentseva Yu.S., Hlynin M.Yu.** Formation and development of industrial clusters. *Technical and technological problems of service*, 2014, no. 1(27), pp. 92−99. (rus)

7. **Gordey K.G.** Konfigurirovaniye of systems of deliveries in a format of a logistic cluster. *The Theory and practice of service: economy, social sphere, technologies*, 2015, no. 2(24), pp. 69−72. (rus)

8. Gorelova Ya.S. Comparison of clusters and other forms of the organizations. *News of the St. Petersburg state economic university*, 2015, no. 6, pp. 103—105. (rus)

9. Cluster structure of an industrial economy: the monograph. Under the editorship of A.V. Babkin. St. Petersburg, St. Petersburg state polytechnical university, 2014. 300 p. (rus)

10. **Carpenters of VA., Sergeyev P.V., Timofeeva S.V.** Innovative and technological support of management of development of regional pharmaceutical clusters. *News of Southwest state university. Series: Economy. Sociology. Management*, 2011, no. 2, pp. 92—97. (rus)

11. **Svetovtseva M.G.** Management of formation of an economic kernel of the region: yew. ... edging. экон. sciences. Voronezh, 2004. 270 p. (rus)

12. **Soloveychik K.A.** Conceptual bases of creation of innovative industrial clusters in Russia: monograph. St. Petersburg, Publisher of the St. Petersburg state. un-t of economy and finance, 2010. (rus)

13. Clusters and Regional Specialisation. On Geography, Technology and Networks. Ed. by M. Steiner. London, Pion, 1998.

14. **Delgado M., Porter M., Stern S.** Clusters, Convergence, and Economic Performance. Institute for Strategy and Competitiveness. March 11, 2011.

15. **Porter M.E.** Clusters and the new economics of competition. *Harvard Business Review*, 1998, no. 76(6), pp. 77—90.

СПИСОК ЛИТЕРАТУРЫ

1. **Аркин П.А., Голубев А.Г.** Структуризация инновационного процесса в кластере: информационно-логистический метод // Известия Санкт-Петербургского государственного экономического университета. 2014. № 1. С. 58-62.

2. **Бабкин А.В., Новиков А.О.** Кластер как субъект экономики: сущность, современное состояние, развитие // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2016. № 1(235). С. 9—29. DOI: 10.5862/JE.235.1

3. **Барсуков Д.П., Кудряшов В.С.** Формирование промышленного кластера: теоретические и методические аспекты: моногр. СПб., 2014.

4. **Бородкина Е.В., Рисин И.Е.** Государственное управление процессами кластеризации социально-экономического пространства региона: моногр. Воронеж: Изд-во ВГПУ, 2011. 159 с.

5. **Вертакова Ю.В., Плотников В.А.** Типологизация подходов к формированию и развитию пропульсивных кластеров в экономике региона // Экономика и управление. 2016. № 3(125). С. 10—18.

6. **Вертакова Ю.В., Положенцева Ю.С., Хлынин М.Ю.** Формирование и развитие промышленных кластеров // Технико-технологические проблемы сервиса. 2014. № 1(27). С. 92—99.

7. **Гордей К.Г.** Конфигурирование систем поставок в формате логистического кластера // Теория и практика сервиса: экономика, социальная сфера, технологии. 2015. № 2(24). С. 69—72.

8. **Горелова Я.С.** Сравнение кластеров и других форм организаций // Известия Санкт-Петербургского государственного экономического университета. 2015. № 6. С. 103—105.

9. Кластерная структура экономики промышленности: моногр. / под ред. А.В. Бабкина. СПб.: Изд-во Политехн. ун-та, 2014. 300 с.

10. **Плотников В.А., Сергеев П.В., Тимофеева С.В.** Инновационно-технологическая поддержка управления развитием региональных фармацевтических кластеров // Известия Юго-Западного государственного университета. Серия: Экономика. Социология. Менеджмент. 2011. № 2. С. 92—97.

11. **Световцева М.Г.** Управление формированием экономического ядра региона: дис. ... канд. экон. наук. Воронеж, 2004. 270 с.

12. **Соловейчик К.А.** Концептуальные основы создания инновационных промышленных кластеров в России: моногр. СПб.: Изд-во СПбГУЭФ, 2010.

13. Clusters and Regional Specialisation. On Geography, Technology and Networks / ed. by M. Steiner. London: Pion, 1998.

14. Delgado M., Porter M., Stern S. Clusters, Convergence, and Economic Performance. — Institute for Strategy and Competitiveness. March 11, 2011.

15. **Porter M.E.** Clusters and the new economics of competition // Harvard Business Review, 1998, no. 76(6). pp. 77—90.

BABKIN Alexander V. — professor of the Higher school of industrial management and economy of the St. Petersburg polytechnical university of Peter the Great, the Doctor of Economics, professor.

195251, Politekhnicheskaya str. 29. St. Petersburg. Russia. Phone: 8(812)591-66-58. E-mail — babkin@spbstu.ru, al-vas@mail.ru

БАБКИН Александр Васильевич — профессор Высшей школы промышленного менеджмента и экономики Санкт-Петербургского политехнического университета Петра Великого, доктор экономических наук, профессор;

195251, ул. Политехническая, д. 29, Санкт-Петербург, Россия. Тел.: 8(812)591-66-58. E-mail: babkin@spbstu.ru, al-vas@mail.ru.

VERTAKOVA Yuliya V. − department of regional economics and management, faculty of Economics and Management, Southwest State University, head of the department of regional economics and management.

305040. 50 let Oktyabrya str. 94. Kursk. Russia. E-mail: vertakova7@yandex.ru

ВЕРТАКОВА Юлия Владимировна − заведующий кафедрой «Региональная экономика и менеджмент» Юго-Западного государственного университета, доктор экономических наук.

305040, ул. 50 лет Октября, д. 94, г. Курск, Россия. Тел. +7(910)316-66-71. E-mail: vertakova7@yandex.ru

PLOTNIKOV Vladimir A. − Saint-Petersburg State University of Economics.

191023. Sadovaya str. 21. St. Petersburg. Russia. E-mail: Plotnikov_2000@mail.ru

ПЛОТНИКОВ Владимир Александрович − профессор Санкт-Петербургского государственного экономического университета, доктор экономических наук, профессор.

191023, ул. Садовая, д. 21, Санкт-Петербург, Россия. Тел.: 8(911)949-13-21. E-mail: Plotnikov_2000@mail.ru

V.A. Volkov, S.R. Razmanova

TECHNOLOGICAL MODERNIZATION
OF THE OIL AND GAS INDUSTRY:
THE CURRENT STATE AND PROSPECTS OF DEVELOPMENT

А.А. Волков, С.В. Разманова

ТЕХНОЛОГИЧЕСКАЯ МОДЕРНИЗАЦИЯ НЕФТЕГАЗОВОЙ ОТРАСЛИ:
СОВРЕМЕННОЕ СОСТОЯНИЕ И ПЕРСПЕКТИВЫ РАЗВИТИЯ

In Russia today there is a gap between modern breakthrough technologies that should serve as an engine of economic development and industries that operate on technological equipment of the previous generation. At the same time, the modernization of production cannot be centered around renewing only the companies' fixed assets. The aim of the study is to analyze the current technological state of the oil and gas industry of the Russian Federation, the dynamics of investments in R&D by domestic and foreign oil and gas companies, the impact of sanctions on the modernization of the sector. The level of innovative activity in the oil and gas industry in 2013-2014 remained unchanged. The direction of technological innovation continues to depend on the future activities of the companies. The Russian company «Tatneft», which is one of the eight leading domestic vertically integrated companies and has been among the leading companies in the number of patents and inventions in the past five years but it is not the leader in the field of extraction and processing of hydrocarbons. From 2008 to 2014, there was an increase in the ratio of R&D to sales in virtually all oil and gas companies, but foreign companies remain the leaders in the volume of investment in R&D, both in absolute and relative terms. As a result of the analysis, the authors concluded that in Russia there is a reserve for the technological development of the industry, but the current high dependence on foreign technology in the commodity sector remains and is, unfortunately, unavoidable in the midterm. Production modernization in the oil and gas industry cannot consist only in updating the main funds of companies, as disregarding the implementation of new technologies by state and businessesleads to a loss of long-term competitive advantages of domestic companies.

TECHNOLOGICAL MODERNIZATION; IMPORT SUBSTITUTION; INTELLECTUAL PROPERTY; INNOVATION; POSTINDUSTRIAL ECONOMY.

Сегодня в России наблюдается некий разрыв между современными прорывными технологиями, которые должны послужить локомотивом развития экономики, и отраслями промышленности, функционирующими на поколении оборудования прежних технологических укладов. Вместе с тем модернизация производства не может заключаться только в обновлении основных фондов компаний. Целью исследования стал анализ текущего технологического состояния нефтяной и газовой промышленности России, динамики инвестиций в R&D отечественных и зарубежных нефтяных и газовых компаний, влияния санкций на модернизацию сектора. В 2013—2014 гг. уровень инновационной активности в нефтегазовой отрасли оставался неизменным. Выбор направления технологических инноваций продолжает зависеть от предстоящих областей деятельности компаний. Среди компаний-лидеров по числу патентов и изобретений за последние пять лет оказалась российская компания «Татнефть», которая входит в число восьми ведущих отечественных ВИНК, но при этом не является лидером в области добычи и переработки углеводородов. Нефтегазовые компании делают основной упор на развитие технологий в сегменте «добыча». С 2008—2014 гг. произошло увеличение показателя отношения расходов на НИОКР к выручке у большинства нефтегазовых компаний, однако зарубежные фирмы остаются лидерами в объемах инвестирования в НИОКР как в абсолютном выражении, так и в относительном. Сделан вывод, что в России есть резерв для технологического развития отрасли, но в настоящее время высокая зависимость от иностранных технологий в сырьевом секторе остается и, к сожалению, неустранима в среднесрочной перспективе.

ТЕХНОЛОГИЧЕСКАЯ МОДЕРНИЗАЦИЯ; ИМПОРТОЗАМЕЩЕНИЕ; ИНТЕЛЛЕКТУАЛЬНАЯ СОБСТВЕННОСТЬ; ИННОВАЦИИ; ПОСТИНДУСТРИАЛЬНАЯ ЭКОНОМИКА.

Introduction. The advanced technological development of nations, national companies and the private sector is now one of the key strategic vectors. Economies based on advanced technological structure allow to export modern goods and services in return for intellectual rent,

while recipient countries, often without advanced technologies, pay currency received from the exports of natural resources, taking away the resource rents some of which are non-renewable.

In the postindustrial society, the development of innovative productions is carried out with a «clean slate» and is not burdened with a mass of obsolete fixed assets that do not correspond to the spirit of modern times.

Completely rejecting industrial production and replacing it with the post-industrial service economy and clean energy is not possible in our opinion. One has only to refer to the experience of de-industrialization of the UK industry that was reduced in size by two thirds over the last 30 years. The country's leadership was confident that the priority of industries had been left in the past, and the future of the ascending branches was only associated with the knowledge-driven economy. As a result, a number of industrial sectors were destroyed and no alternatives to them have been found so far. The share of employees in manufacturing decreased by 2.7 times, the unemployment rate increased, because the economic system of the country was not prepared to train programmers and researchers from yesterday's workers [1]. It is obvious that the country's industry is the foundation of material production, and makes a fundamental contribution (from 25 to 40 %) to the gross domestic product [2].

Modernizing the Russian economy is extremely urgent and actively discussed at various levels of the institutional system. The modernization of the country is traditionally associated not only with permanent updating but a fundamental change in the direction and pace of economic development. The modernization of the Russian economy, the course of which was adopted by the Russian Government in 2006, should include its innovative development and new industrialization. Industrialization in the classic sense is the process of replacing the primitive, poorly equipped hand labor by machine work. New industrialization is the repetition of this process, but under new conditions, while the re-industrialization is the process of recovering industrial, technological systems, individual sectors and types of production, together with solving major problems related to the stock, technological and human

resource base of the industry, as well as with a common vector for creating innovative domestic products with high added value [3]. In general, technological modernization is a change in the structure of the technological mode of various economic entities in favor of advanced technologies. Industry is the main subject for the changes.

A new financial and economic strategy aimed at accelerating economic growth on the basis of the new industrialization, a sharp increase in industrial investment, and import phase-out was offered by Glazyev [4, 5], Polterovich, Ivanter, Nekipelov, Primakov, Greenberg, Dmitriev, Kuzyk [6, 7] and other leading domestic economists. The problem of strategic development and reindustrialization of old industrial regions also has quite a serious scientific-theoretical basis. The works of both Russian scientists (Amosha, Novikova, Lyashenko, Makogon, Novak, Belinskaya) and foreign ones (Glonti, Boshmy, Lembuya, Steiner, Muller) have been dedicated to it.

Assessing the significance of the scientific research carried out not only by the above-mentioned scientists but also by many others, it should be noted that certain aspects of the problem remain largely controversial or do not find a clear solution under the conditions of a complex geopolitical situation.

In Russia today there is a gap between modern breakthrough technologies that should serve as an engine of economic development and industries that operate using technological equipment of the previous generation. At the same time, the modernization of production cannot be centered around only the renewal of companies' fixed assets, as both the state and the business completely neglecting to implement new technologies results in the loss of long-term competitive advantages of domestic companies.

The objective of the research. In this study, the aim was to analyze the current state of the technological portfolio of domestic oil and gas companies on the basis of the data of their inventive and innovative activities, and to assess the prospects of its development, based on the dynamics of investments in R&D in 2008-2014.

The questions of eliminating the technological backwardness of Russia were always relevant, and that is the reason why

borrowed advanced technologies were present both in the Russian Empire and in the Soviet Union. Even at the time of the Demidovs Russia exported metal and other manufactured goods to Europe, but in those years the Ural metallurgical industry was based on manual labor. Domestic industrialization started only in the late 19th and early 20th centuries. It featured massive urbanization, attraction of previously unused resources thanks to broad railway construction, as well as catch-up development, i.e., the purchase of already developed technologies from abroad using credits and the export of raw materials. In Soviet years, these characteristics have been supplemented by the extensive use of forced labor, the withdrawal of the surplus product of the agricultural complex, the focus primarily on the development of the military industry. Centralized state-run planning did not allow to close outdated production facilities and to develop private initiative [8].

The post-industrial approach actively highlights significant changes in the world economy, raising the questions of how the industry of the 21st century should look like, and what is its place among the variety of services and innovation of high-performance post-industrial regions in comparison to which the industries appear less efficient and hard to transform.

The need for innovative development of industrial production is dictated by the changes in economic conditions (tightening environmental regulations, the transition to a low carbon economy (reducing greenhouse gas emissions, energy efficiency, increasing the share of clean energy [9]), impossibility to ignore the social and

political factors, as well as shifting whole sectors of the domestic economy, such as the oil and gas sector, to a new technological path (in the future). The concept of inclusive economic growth also emphasizes the need for a versatile, balanced approach to the economic development of countries.

According to the Thomson Reuters «2015 State of Innovation» report, the level of innovative activity in the oil and gas industry in 2013−2014 remained unchanged [10, p. 55]. The growth rate of innovation in the industry in 2014 compared to 2013 amounted to 1.0 % (Tab. 1). China is the leader in the field of «exploration, drilling, extraction and processing of oil and gas». The first places are occupied by the Sinopec and PetroChina companies(China), followed by Halliburton and Schlumberger (US). China National Offshore Oil Corp (China) is also ranked fifth. The Sinopec company focuses its innovation mainly on the downstream sector, namely on the fractionation of crude oil, cracking for production of heavy oil and diesel fractions, as well as the synthesis of polymers, aromatics, alcohols, acids and formaldehyde. PetroChina Corporation innovates mainly in the upstream sector of exploration, drilling, production, processing, and wellheads pipeline development technology. Currently, Sinopec and PetroChina are joining their efforts in the sector of processing hydrocarbons.

If we analyze the research in this area it is necessary to include the Imperial College of London (UK) and the US Department of Energy among the leaders. They are followed by Stanford University (USA) and the Technical University of Tallinn (Estonia).

T a b l e 1

Investments in R&D for sub-sectors of the world oil and gas industry in 2013−2014 [10]

Subsectors	Share in total R&D volume	R&D volume		Change, %
		2013	2014	
Petroleum & Gas Exploration, Drilling, Production and Processing	62.5	15480	15589	0.7
Petroleum & Gas Fuels and Other Products	34.2	8464	8459	−0.1
Petroleum & Gas Transportation and Storage	2.6	664	658	−0.9
Petroleum Refining	0.7	178	183	2.8

S o u r c e : Thomson Reuters Derwent World Patents Index/

The methodology of the study. The study used scientific methods of research (comparison, generalization, analogy method, structural analysis and synthesis), logical techniques − theoretical analysis, methods of technical, economic and financial analysis.

The Russian company Tatneft (Tab. 2), which is one of the eight leading domestic vertically integrated companies, but it is not the leader in the field of extraction and processing of hydrocarbons, was among the leading companies in the number of patents and inventions in the past five years. It should be noted that the Thomson Reuters studies pointed to the great potential of this company, as it ranges among the leading oilfield service companies (Halliburton Energy Services, Schlumberger, Baker Hughes), for which the level of innovation is traditionally high, oil majors Exxon Mobil and Shell, as well as a number of scientific institutions. The latter are Korea Aerospace Research Institute, Harbin Institute of Technology, Beijing University of Aeronautics and Astronautics, and Beijing Institute of control technology, whose main task is developing and introducing appropriate innovations.

We have made an analysis of the dynamics of the innovative activities of the leading oil companies on the basis of the Federal Institute of Industrial Property database for the period from 2000 to 2015 (Fig. 1). The data demonstrates that vertically integrated oil companies PJSC Tatneft and PJSC Gazprom are leading at the level of the dynamics of registration of intellectual property in Russia with a considerable gap from other vertically integrated companies.

The structure of intellectual property by type of activity in the leading vertically integrated oil companies in 2000−2015 presented in Fig. 2 indicates that the companies' main focus is on developing technologies in the production segment. Rosneft is the only company for which the dynamics of patents and inventions in the recycling segment slightly predominates over its production segment. At this moment the current structure of the Russian vertically integrated oil companies in favor of investments in technologies that improve the efficiency and processing of hydrocarbons is in line with the trend of investment in R&D by the world oil and gas companies.

Table 2

The leading companies in innovation in the field of oil and gas in 2010−2014 [10]

Company	Country	The number of inventions, units
North America		
Halliburton Energy Services	U.S.	210
Schlumberger	U.S.	50
Baker Hughes	U.S.	41
ExxonMobil	U.S.	34
UOP LLC	U.S.	28
Europe		
Tatneft Stock Co	Russia	211
Shell Oil Co	Netherlands	103
IFP Energy Nouvelles	France	78
Saudi Aramco	Saudi Arabia	52
BASF SE	Germany	42
Asia		
Korea Aerospace Research Institute	South Korea	147
Harbin Institute of Technology	China	139
Aerospace Dongfanghong Satellite	China	97
Beijing University of Aeronautics and Astronautics	China	97
Beijing control technology	China	84
Mitsubishi Electric	Japan	77

S o u r c e : Thomson Reuters Derwent World Patents Index.

The focus on technological modernization of the Russian Federation was announced in 2008 but was not actually supported by either the government or by the business structures. The renewal of fixed assets in the industry will not occur rapidly due to the current Western sanctions, the limitation of provision of high-tech, low exchange rate and limited credit resources. However, in the present situation it is especially important to avoid the creating artificial problems which in the long run can disrupt the development of entire industries [11].

Structuring processes and tools related to the implementation and management of R&D in foreign companies is, as a rule, built in accordance with the business goals and objectives [12—14].

A systematic approach for adapting technologies virtually does not exist at the level of domestic industrial enterprises. Companies act based on the current situation often without any innovative programs. Therefore, they have to incorporate new technological solutions that have been created in-house or purchased earlier, in some cases using the concept of «open» innovation.

The innovative development programs of oil and gas companies (if these programs exist at all in a company) reflect the following information: the amount of R&D funding with respect to the company's level of revenues, target-based technologies and the base for creating them (the research department of an organization, outsourcing or trendy «open innovation»).

The indicator of investments in innovation as the percentage of R&D costs to the cash turnover is customarily used to assess the degree to which a company is integrated into the high-tech industry. If this ratio exceeds 5 %, the company can be attributed to the high-tech industry [15].

From 2008 to 2014, there was an increase in the ratio of R&D to sales in virtually all oil and gas companies, presented in Table 3, but foreign companies remain the leaders in the volume of investment in R&D, both in absolute and relative terms. Despite the fact that the majority of Russian companies have created innovation development programswith long-term technological priorities, the investments of Russian commodity companies in the technology, which in fact can be considered innovative, have not in most cases been a strategic priority for the companies in the period of high oil prices. Domestic oil and gas companies had had little interest in science before the EU and the US announced their sanctions, because the quality of their products had remained virtually unchanged and quite competitive. «The main R&D have been associated with the cost reduction for the extraction of minerals and their transportation. But such studies are poorly connected with high technology« [40]. In the current situation, to maintain the stability of the Russian economy, it is essential to maintain the volume of oil and gas at least at the current levels. Today, this problem has no simple solutions, as in the current crisis it is becoming more difficult and expensive to extract hydrocarbons, and the investments in the development of domestic innovations are still far from the desired level.

Table 3

Investments in R&D Russian commodity companies compared with foreign corporations in 2008—2014 [16—39]

Company	2008			2012			2014		
	R&D expenses, mln $.	Revenue, billion $.	The ratio of R&D expenses to revenue, %	R&D expenses, mln $.	Revenue, billion $.	The ratio of R&D expenses to revenue, %	R&D expenses, mln $.	Revenue, billion $.	The ratio of R&D expenses to revenue, %
Shell	1230	458.4	0.27	1307	467.2	0.28	1222	421.1	0.29
Exxon Mobil	847	459.6	0.18	1042	451.5	0.23	971	394.1	0.25
Surgutneftegaz	40.6	23.2	0.18	37.9*	27.97	0.16	38.9	15.83	0.25
Tatneft	26.7	17.9	0.15	19.9	14.62	0.14	7.1*	8.47	0.08
Gazprom	197.5	136.42	0.14	253.5	157	0.16	192	99.4	0.19
Lukoil	95	86.7	0.11	157	139.2	0.11	154	144.2	0.11
Rosneft	10.9	45.9	0.02	327	101.35	0.32	590.2	97.82	0.6
IBM	6000	103.6	5.8	6302	104.5	6.03	5437	98.8	5.5

S o u r c e : Our estimates for 2012 and 2014 based on the data from oil and gas companies* the calculations include data for the first three quarters of these years.

The problem of depending on foreign equipment in industry has aggravated because of the sanctions. The Energy Minister stresses the need for investments in R&D and engineering, noting that imported equipment is mainly used when developing offshore fields, due to the lack of Russian counterparts or because they do not conform to technical requirements. In his opinion, a weak point in the Russian market is the lack of domestic specialized software, compressor equipment and turbines [40]. In addition, Russian companies are the most dependent on the equipment for production of hydraulic fracturing, horizontal drilling, telemetry and technological support at angle and horizontal drilling.

Industry experts consider the need for tax reform in the oil and gas industry as an incentive to the innovative development of the industry [41−44][1]. Innovative methods of hydrocarbon extraction, which would help maintain current production levels, are very expensive and the existing tax system is inefficient economically. There are mechanisms of taxation in the sector that are being discussed now, according to which taxation should concern the financial results and not the physical production. Not only the mining companies and the representatives of the Government, but also the Ministry of Energy and the Natural Resources Ministry have supported the measure. It is expected that the relevant draft amendments to the existing legislation will be submitted to the State Duma in the spring of 2016. In addition, a tax on already depreciated property can become a specific driver for modernizing the companieshe in the industry.

Currently, the Government of the Russian Federation has approved the roadmap «The introduction of innovative technologies and modern materials in the fuel and energy complex» in which at least twenty national projects on introduction of innovative technologies and new materials in the fields of fuel energy complex will be implemented by 2018. The program also points out that the increase in the volumes of shipping (release) of products, works and services to customers and clients in the fuel and energy complex, produced with the use of innovative technologies and modern materials should be at least 5 percent per year compared to the previous year [45]. According to the project of the Energy Strategy of Russia, for the period until 2035 the share of imported machinery in the amount of purchased equipment could reach no more than 12 % by the end of the first stage of the strategy, no more than 8 % by the end of the second stage, and would drop to 3−5 % by 2035.

Experts point out that companies specializing in the promotion of innovative technologies need to beprovided with access to deposits forconducting tests. This means creating full-fledged test sites in which small innovative enterprises could develop their technology. Oil service companies are suggested to be used ss an integrator, as large vertically integrated oil companies typically strive to obtain a finished service instead of testing a new technology.

The novelty of the obtained results of the study is in the following:

1. the dynamics of the inventive activity of the leading Russian oil and gas companies has been proved;

2. the structure of the intellectual property rights of the Russian vertically integrated oil companies by type of activity has been revealed;

3. the investments in R&D for the leading Russian oil and gas companies in 2008-2014 have been analyzed.

Results. At the state level, the degree of preparedness for the innovations can be evaluated using the innovative ranking of UNESCO. In the global innovation ranking of 2014 prepared by UNESCO, the Russian Federation took the 49th place among 143 countries [46]. The UNESCO study has not identified any fall in the total costs in R&D resulting from the crisis of 2008−2009 in the majority of countries of Eastern Europe, and in major European countries, such as France and Germany, in some Asian economies with high

---

[1] More recently, there was a transition from a flat to a differentiated scale of taxation in the oil and gas industry of the Russian Federation. For example, the taxation mechanism of gas extraction and condensate has undergone dramatic changes after the introduction of amendments to the 01.07.2014 art. 342, Sec. 26 of the Tax Code on the basis of the Federal Law 263-FZ of 30.09.2013. However, the benefits resulting from these amendments lasted only 6 months and were virtually offset by the provisions of Federal Law 366-FZ of 11.24.2014 since 01.01.2015.

income (the Republic of Korea), and in countries with developing economies (China and the Russian Federation). However, the energy industry today faces serious challenges that require adequate attention, both from the government and corporations [14]. IEA and international patent offices noted a huge potential for scientific research in this area.

The experience of developed countries shows the special role of industrial and innovation policy in stimulating promotion and commercialization of new technologies in the market [47, 48].

In the 2008−2009 crisis and the subsequent recovery phase in 2010−2014, the level of costs in R&D from the state and business structures in the Russian economy was kept at a stable yet low level.

The ban on the technological transfer of technologies for deepwater drilling and LNG projects has shown the dependence of the domestic oil and gas industry on the advanced projects of Western suppliers. The analysis carried out by the experts of the Russian Ministry of Energy showed that most of the equipment imported by Russian oil and gas companies can be replaced today by Russian or foreign analogues produced in countries that do not support sanctions. However, only a partial replacement of such equipment can be performed within the three-year period. Full replacement will only be possible by 2020. Of course, there is a reserve for the technological development of the industry in Russia, but the current high dependence on foreign technology in the commodity sector remains and is, unfortunately, unavoidable in the midterm. *Further directions of research* include the study and analysis of the characteristics of financing innovations in oil and gas companies, as well as defining country specifics for the types of companies under consideration.

REFERENCES

1. Pochemu Velikobritaniia bol'she ne delaet veshchi? URL: http://www.theguardian.com/business/2011/nov/16/why-britain-doesnt-make-things-manufacturing (provereno: 21.12.2015). (rus)

2. **Sukharev O.S., Strizhakova E.N.** Industrial'naia politika i razvitie promyshlennykh system. *Natsional'nye interesy: prioritety i bezopasnost'.* 2014. № 15. S. 2−21. (rus)

3. **Sukharev O.S.** Reindustrializatsiia ekonomiki i tekhnologicheskoe razvitie. *Mir novoi ekonomiki.* 2014. № 2. S. 21−28. (rus)

4. **Glaz'ev S.Iu., Dement'ev V.E.** Stanovlenie novogo tekhnologicheskogo uklada v rossiiskoi ekonomike. *Nanotekhnologii kak kliuchevoi faktor novogo tekhnologicheskogo uklada v ekonomike.* Pod red. akademika RAN S.Iu. Glaz'eva i professora V.V. Kharitonova. M.: Trovant, 2009. 304 s. (rus)

5. **Glaz'ev S., Fetisov G.** Novyi kurs: strategiia proryva: nauch. Doklad. *Doklady RAN. Sovet po izucheniiu proizvoditel'nykh sil. Natsional'nyi institut razvitiia.* 2012. 49 s. (rus)

6. **Bliakhman L.S.** Institutsional'nye osnovy modernizatsii rossiiskoi ekonomiki. *Problemy sovremennoi ekonomiki.* 2012. № 1. S. 7−17. (rus)

7. **Kuzyk B.** O formirovanii sistemy strategicheskogo upravleniia modernizatsiei i razvitiem rossiiskoi ekonomiki. *Ekonomicheskie strategii.* 2014. № 2. S. 24−29. (rus)

8. Novaia industrializatsiia Rossii. Teoreticheskie i upravlencheskie aspekty: koll. monogr. / pod nauch. red. d-ra ekon. nauk N.F. Gazizullina. SPb.: NPK «ROST», 2014. 237 s. (rus)

9. Perspektivy razvitiia energeticheskikh tekhnologii − 2015. MEA. URL: http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2015ExecutiveSummaryRussianversion.pdf (provereno: 21.12.2015). (rus)

10. Thomson Reuters. Global'nyi otchet o kliuchevykh innovatsiiakh 2015. URL: http://wokinfo.com/media/pdf/State_of_Innovation_RUS.pdf (provereno: 08.12.2015).

11. Katastrofy i otkaty: kak razvalivaetsia Rossiia. URL: http://www.rbc.ru/opinions/economics/07/07/2015/559a86919a79472ad2d31d2a (provereno: 21.12.2015). (rus)

12. Ruy dos Santos de Quadros Carvalho, Glicia Vieira dos Santos, Manoel Clementino de Barros Neto R&D+ i Strategic Management in a Public Company in the Brazilian Electric Sector. *Journal of Technology Management & Innovation*, 2013, vol. 8, is. 2, pp. 235−256.

13. **Hartley P., Kenneth B. Medlock.** A model of the operation and development of a National Oil Company. *Energy Economics*, 2008, vol. 30, is. 5, pp. 2459−2485.

14. **Costa-Campi M.T., Duch-Brown N., García-Quevedo J.** R&D drivers and obstacles to innovation in the energy industry. *Energy Economics*, 2014, vol. 46, is. 6, pp. 20−30.

15. **Pakhomova N.V., Rikhter K.K.** Ekonomika otraslevykh rynkov i politika gosudarstva. M.: Ekonomika, 2009. 815 s. (rus)

16. Kak zastavit' «Gazprom» i neftianikov investirovat' v innovatsii? CNews konsul'tiruet gosudarstvo. URL: http://oko-planet.su/politik/politik rus/25632-kak-zastavit-gazprom-i-neftyanikov-investirovat-v.html (provereno: 08.12.2015). (rus)

17. Ezhekvartal'nyi otchet OAO «Surgutneftegaz» za 1 kvartal 2015 g. URL: http://www.surg utneftegas.ru /ru/investors/reports/quarterly/ (provereno: 15.01.2016). (rus)

18. Ezhekvartal'nyi otchet OAO «Surgutneftegaz» za 1−3 kvartaly 2012 g. URL: http://www.su rgutn eftegas.ru/ru/investors/reports/quarterly/ (provereno: 15.01.2016). (rus)

19. Godovaia konsolidirovannaia finansovaia otchetnost' OAO «Surgutneftegaz» za 2012 g. URL: http://www.surgutneftegas.ru/ru/investors/reports/5_5 / (provereno: 15.01.2016). (rus)

20. Godovaia konsolidirovannaia finansovaia otchetnost' OAO «Surgutneftegaz» za 2014 g. URL: http://www.surgutneftegas.ru/ru/investors/reports/5_5 / (provereno: 15.01.2016). (rus)

21. Godovaia konsolidirovannaia finansovaia otchetnost' OAO «Tatneft'» za 2013 g. URL: http://www.tatneft.ru/storage/block_editor/files/b6f2f8 6255029875f9cd2555568fb9e031224934.pdf (provereno: 15.01.2016). (rus)

22. Godovaia konsolidirovannaia finansovaia otchetnost' OAO «Tatneft'» za 2014 g. URL: http://www.tatneft.ru/storage/block_editor/files/1c6b5 fd09b00792fe57104b1471906922ef82803.pdf (provereno: 15.01.2016). (rus)

23. Ezhekvartal'nyi otchet OAO «Tatneft'» im. V.D. Shashina za 1−3 kvartaly 2014 g. URL: http:// www.tatneft.ru/aktsioneram-i-investoram/raskritie-info rmatsii/ezhekvartalniy-otchet?lang=ru (provereno: 15.01.2016). (rus)

24. Ezhekvartal'nyi otchet OAO «Tatneft'» im. V.D. Shashina za 1 kvartal 2013 g. URL: http:// www.tatneft.ru/aktsioneram-i-investoram/raskritie-info rmatsii/ezhekvartalniy-otchet?lang=ru (provereno: 15.01.2016). (rus)

25. Spravochnik «Gazprom v tsifrakh 2010−2014». URL: http://www.gazprom.ru/f/posts/05/298369/gazpr om-in-figures-2010-2014-ru.pdf (provereno: 15.01.2016). (rus)

26. Godovoi otchet OAO «Lukoil» za 2014 g. URL: http://www.lukoil.ru/materia ls/doc/ AGSM_ 2015/LUKOIL_AR_rus_2014.pdf (provereno: 15.01.2016). (rus)

27. Godovoi otchet OAO «Neftianaia kompaniia «Lukoil» za 2012 g. URL: http://www.lukoil.ru/ma terials/doc/AGSM_2013/AR_2012_final_rus.pdf (provereno: 15.01.2016). (rus)

28. Konsolidirovannaia finansovaia otchetnost' OAO «NK «Rosneft'» za 2014 g. URL: http://www. rosneft.ru/attach/0/12/99/Rosneft_FS_2014_RUS.pdf (provereno: 15.01.2016). (rus)

29. Konsolidirovannaia finansovaia otchetnost' OAO «NK «Rosneft'» za 2012 g. URL: http://www. rosneft.ru/attach/0/02/90/Rosneft_FS_2012_RUS.pdf (provereno: 15.01.2016). (rus)

30. Ezhekvartal'nyi otchet OAO «Neftianaia kompaniia «Rosneft'» za 1 kvartal 2013 g. URL: http://www.rosneft.ru/attach/0/16/07/qreport_1_2013. pdf (provereno: 15.01.2016). (rus)

31. Ezhekvartal'nyi otchet OAO «Neftianaia kompaniia «Rosneft'» za 1 kvartal 2015 g. URL: http://www.rosneft.ru/attach/0/16/06/qreport_1_2015. pdf (provereno: 15.01.2016). (rus)

32. Raskhody Royal Dutch Shell na NIOKR 2010−2014 gg. URL: http://www.statista.com/statist ics/260315/spending-on-research-and-development-by-royal-dutch-shell/ (provereno: 15.01.2016). (rus)

33. Konsolidirovannyi otchet o pribyliakh Royal Dutch Shell za 2014 g. URL: http://reports.shell.com/ investors-handbook/2014/consolidated-data/statement-of-income.html (provereno: 15.01.2016). (rus)

34. Raskhody Exxon Mobil na NIOKR 2001−2014 gg. URL: http://www.statista.com/statistics/28 1239/research-and-development-costs-of-exxon-mobil/ (provereno: 15.01.2016). (rus)

35. Dokhod Exxon Mobil 2001−2014 gg. URL: http://www.statista.com/statistics/264119/revenue-of-exxon-mobil-since-2002/ (provereno: 15.01.2016). (rus)

36. Godovoi otchet IBM za 2012 g. URL: http://www.ibm.com/investor/att/pdf/4Q12-Press-Release.pdf (provereno: 15.01.2016). (rus)

37. Godovoi otchet IBM za 2014 g. URL: http://www.ibm.com/investor/att/pdf/IBM-4Q14-Earnings-Press-Release.pdf (provereno: 15.01.2016). (rus)

38. Raskhody IBM na NIOKR 2003−2015 gg. URL: https://ycharts.com/companies/IBM/r_and_d_ expense (provereno: 15.01.2016). (rus)

39. Ofitsial'nyi obmennyi kurs rublia 2004−2015 gg. URL: http://cbr.ru/statistics/print.aspx?file=credi t_statistics/ex_rate_ind_14.htm&pid=svs&sid=analit (provereno: 15.01.2016). (rus)

40. **Razmanova S.V.** Intellektual'nyi kapital neftegazovykh kompanii − zalog konkurentnogo preimushchestva na global'nykh rynkakh. *Mineral'nye resursy Rossii. Ekonomika i upravlenie.* 2012. № 2. S. 57−61. (rus)

41. Kak innovatsii spasut neftegaz. URL: http://i.rbc.ru/anons/item/kak_innovatsii_spasut_nefte gaz (provereno: 15.01.2016). (rus)

42. Mazurina E.V. Dobycha uglevodorodov kak istochnik dokhodov gosudarstva i nedropol'zovatelei. *Neftegazovaia geologiia. Teoriia i praktika.* 2014. T. 9. № 1. URL: http://www.ngtp.ru/rub/3/33_2014.pdf (rus)

43. **Razmanova S.V., Shul'ts E.V.** Nalogovaia politika gosudarstva kak instrument stimulirovaniia innovatsionnykh tekhnologii v neftegazovoi sfere. *Neftegazovaia geologiia. Teoriia i praktika: elektron. nauch. zhurnal.* 2011. T. 6. № 1. URL: http://www. ngtp.ru/rub/3/1_2011.pdf (rus)

44. **Razmanova S.V., Shul'ts E.V.** Innovatsionnye mekhanizmy v ekonomike neftegazovoi otrasli. *Neftegazovaia geologiia. Teoriia i praktika: elektron. nauch. zhurnal.* 2013. T. 8. № 1. URL: http://www.ngtp.ru/rub/3/9_2013.pdf (rus)

45. Plan meropriiatii («dorozhnaia karta») «Vnedrenie innovatsionnykh tekhnologii i sovremennykh materialov v otrasliakh toplivno-energeticheskogo kompleksa» na period do 2018 goda (utv. Rasporiazh. Pravitel'stva RF № 1217-r ot 03.07.2014 g.). URL: http://government.ru/media/files/41d4eeb21a3d62bbd063.pdf (provereno: 15.01.2016). (rus)

46. Global'nyi innovatsionnyi indeks — 2014. IuNESKO. URL: http://www.uis.unesco.org/Library/Documents/global-innovation-index-2014-human-factor-in-innovation-en.pdf (provereno: 21.12.2015). (rus)

47. **Bointner R.** Innovation in the energy sector: Lessons learnt from R&D expenditures and patents in selected IEA countries. *Energy Policy*, 2014, vol. 73, pp. 733—747.

48. **Kimura O.** Public R&D and commercialization of energy-efficient technology: A case study of Japanese projects. *Energy Policy*, 2010, vol. 38, is. 11, pp. 7358—7369.

СПИСОК ЛИТЕРАТУРЫ

1. Почему Великобритания больше не делает вещи? URL: http://www.theguardian.com/business/2011/nov/16/why-britain-doesnt-make-things-manufacturing (проверено: 21.12.2015).

2. **Сухарев О.С., Стрижакова Е.Н.** Индустриальная политика и развитие промышленных систем // Национальные интересы: приоритеты и безопасность. 2014. № 15. С. 2—21.

3. **Сухарев О.С.** Реиндустриализация экономики и технологическое развитие // Мир новой экономики. 2014. № 2. С. 21—28.

4. **Глазьев С.Ю., Дементьев В.Е.** Становление нового технологического уклада в российской экономике // Нанотехнологии как ключевой фактор нового технологического уклада в экономике / под ред. академика РАН С.Ю. Глазьева и профессора В.В. Харитонова. М.: Тровант, 2009. 304 с.

5. **Глазьев С., Фетисов Г.** Новый курс: стратегия прорыва: науч. доклад // Доклады РАН. Совет по изучению производительных сил. Национальный институт развития. 2012. 49 с.

6. **Бляхман Л.С.** Институциональные основы модернизации российской экономики // Проблемы современной экономики. 2012. № 1. С. 7—17.

7. **Кузык Б.** О формировании системы стратегического управления модернизацией и развитием российской экономики // Экономические стратегии. 2014. № 2. С. 24—29.

8. Новая индустриализация России. Теоретические и управленческие аспекты: колл. моногр. / под науч. ред. д-ра экон. наук Н.Ф. Газизуллина. СПб.: НПК «РОСТ», 2014. 237 с.

9. Перспективы развития энергетических технологий — 2015. МЭА. URL: http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2015ExecutiveSummaryRussianversion.pdf (проверено: 21.12.2015).

10. Thomson Reuters. Глобальный отчет о ключевых инновациях 2015. URL: http://wokinfo.com/media/pdf/State_of_Innovation_RUS.pdf (проверено: 08.12.2015).

11. Катастрофы и откаты: как разваливается Россия. URL: http://www.rbc.ru/opinions/economics/07/07/2015/559a86919a79472ad2d31d2a (проверено: 21.12.2015).

12. Ruy dos Santos de Quadros Carvalho, Glicia Vieira dos Santos, Manoel Clementino de Barros Neto R&D+ i Strategic Management in a Public Company in the Brazilian Electric Sector // Journal of Technology Management & Innovation, 2013, vol. 8, is. 2, pp. 235—256.

13. **Hartley P., Kenneth B. Medlock.** A model of the operation and development of a National Oil Company // Energy Economics, 2008, vol. 30, is. 5, pp. 2459—2485.

14. **Costa-Campi M.T., Duch-Brown N., Garcna-Quevedo J.** R&D drivers and obstacles to innovation in the energy industry // Energy Economics, 2014, vol. 46, is. 6, pp. 20—30.

15. **Пахомова Н.В., Рихтер К.К.** Экономика отраслевых рынков и политика государства. М.: Экономика, 2009. 815 с.

16. Как заставить «Газпром» и нефтяников инвестировать в инновации? CNews консультирует государство. URL: http://oko-planet.su/politik/politikrus/25632-kak-zastavit-gazprom-i-neftyanikov-investirovat-v.html (проверено: 08.12.2015).

17. Ежеквартальный отчет ОАО «Сургутнефтегаз» за 1 квартал 2015 г. URL: http://www.surgutneftegas.ru/ru/investors/reports/quarterly/ (проверено: 15.01.2016).

18. Ежеквартальный отчет ОАО «Сургутнефтегаз» за 1—3 кварталы 2012 г. URL: http://www.surgutneftegas.ru/ru/investors/reports/quarterly/ (проверено: 15.01.2016).

19. Годовая консолидированная финансовая отчетность ОАО «Сургутнефтегаз» за 2012 г. URL: http://www.surgutneftegas.ru/ru/investors/reports/5_5/

(проверено: 15.01.2016).

20. Годовая консолидированная финансовая отчетность ОАО «Сургутнефтегаз» за 2014 г. URL: http://www.surgutneftegas.ru/ru/investors/reports/5_5 / (проверено: 15.01.2016).

21. Годовая консолидированная финансовая отчетность ОАО «Татнефть» за 2013 г. URL: http://www.tatneft.ru/storage/block_editor/files/b6f2f8 6255029875f9cd2555568fb9e031224934.pdf (проверено: 15.01.2016).

22. Годовая консолидированная финансовая отчетность ОАО «Татнефть» за 2014 г. URL: http://www.tatneft.ru/storage/block_editor/files/1c6b5 fd09b00792fe57104b1471906922ef82803.pdf (проверено: 15.01.2016).

23. Ежеквартальный отчет ОАО «Татнефть» им. В.Д. Шашина за 1−3 кварталы 2014 г. URL: http://www.tatneft.ru/aktsioneram-i-investoram/raskri tie-informatsii/ezhekvartalniy-otchet?lang=ru (проверено: 15.01.2016).

24. Ежеквартальный отчет ОАО «Татнефть» им. В.Д. Шашина за 1 квартал 2013 г. URL: http:// www.tatneft.ru/aktsioneram-i-investoram/raskritie-inf ormatsii/ezhekvartalniy-otchet?lang=ru (проверено: 15.01.2016).

25. Справочник «Газпром в цифрах 2010−2014». URL: http://www.gazprom.ru/f/posts/05/298369/gazpro m-in-figures-2010-2014-ru.pdf (проверено: 15.01.2016).

26. Годовой отчет ОАО «Лукойл» за 2014 г. URL: http://www.lukoil.ru/materials/doc/AGSM_2015 /LUKOIL_AR_rus_2014.pdf (проверено: 15.01.2016).

27. Годовой отчет ОАО «Нефтяная компания «Лукойл» за 2012 г. URL: http://www.lukoil.ru/mat erials/doc/AGSM_2013/AR_2012_final_rus.pdf (проверено: 15.01.2016).

28. Консолидированная финансовая отчетность ОАО «НК «Роснефть» за 2014 г. URL: http://www.rosneft.ru/attach/0/12/99/Rosneft_FS_20 14_RUS.pdf (проверено: 15.01.2016).

29. Консолидированная финансовая отчетность ОАО «НК «Роснефть» за 2012 г. URL: http://www.rosneft.ru/attach/0/02/90/Rosneft_FS_20 12_RUS.pdf (проверено: 15.01.2016).

30. Ежеквартальный отчет ОАО «Нефтяная компания «Роснефть» за 1 квартал 2013 г. URL: http://www.rosneft.ru/attach/0/16/07/qreport_1_2013. pdf (проверено: 15.01.2016).

31. Ежеквартальный отчет ОАО «Нефтяная компания «Роснефть» за 1 квартал 2015 г. URL: http://www.rosneft.ru/attach/0/16/06/qreport_1_2015. pdf (проверено: 15.01.2016).

32. Расходы Royal Dutch Shell на НИОКР 2010−2014 гг. URL: http://www.statista.com/statistics /260315/spending-on-research-and-development-by-royal-dutch-shell/ (проверено: 15.01.2016).

33. Консолидированный отчет о прибылях Royal Dutch Shell за 2014 г. URL: http://reports. shell.com/investors-handbook/2014/consolidated-data/ statement-of-income.html (проверено: 15.01.2016).

34. Расходы Exxon Mobil на НИОКР 2001−2014 гг. URL: http://www.statista.com/statistics/28 1239/research-and-development-costs-of-exxon-mobil/ (проверено: 15.01.2016).

35. Доход Exxon Mobil 2001−2014 гг. URL: http://www.statista.com/statistics/264119/revenue-of-exxon-mobil-since-2002/ (проверено: 15.01.2016).

36. Годовой отчет IBM за 2012 г. URL: http://www.ibm.com/investor/att/pdf/4Q12-Press-Release.pdf (проверено: 15.01.2016).

37. Годовой отчет IBM за 2014 г. URL: http://www.ibm.com/investor/att/pdf/IBM-4Q14-Earnings-Press-Release.pdf (проверено: 15.01.2016).

38. Расходы IBM на НИОКР 2003−2015 гг. URL: https://ycharts.com/companies/IBM/r_and_d_ expense (проверено: 15.01.2016).

39. Официальный обменный курс рубля 2004−2015 гг. URL: http://cbr.ru/statistics/print.aspx?file =credit_statistics/ex_rate_ind_14.htm&pid=svs&sid=a nalit (проверено: 15.01.2016).

40. **Разманова С.В.** Интеллектуальный капитал нефтегазовых компаний − залог конкурентного преимущества на глобальных рынках // Минеральные ресурсы России. Экономика и управление. 2012. № 2. С. 57−61.

41. Как инновации спасут нефтегаз. URL: http://i.rbc.ru/anons/item/kak_innovatsii_spasut_nefte gaz (проверено: 15.01.2016).

42. **Мазурина Е.В.** Добыча углеводородов как источник доходов государства и недропользователей // Нефтегазовая геология. Теория и практика. 2014. Т. 9. № 1. URL: http://www.ngtp.ru/rub/3/33 _2014.pdf

43. **Разманова С.В., Шульц Е.В.** Налоговая политика государства как инструмент стимулирования инновационных технологий в нефтегазовой сфере // Нефтегазовая геология. Теория и практика: [электрон. науч. журнал]. 2011. Т. 6. № 1. URL: http://www.ngtp.ru/rub/3/1_2011.pdf

44. **Разманова С.В., Шульц Е.В.** Инновационные механизмы в экономике нефтегазовой отрасли // Нефтегазовая геология. Теория и практика: [электрон. науч. журнал]. 2013. Т. 8. № 1. URL: http://www.ngtp.ru/rub/3/9_2013.pdf

45. План мероприятий («дорожная карта») «Внедрение инновационных технологий и современных материалов в отраслях топливно-энергетического комплекса» на период до 2018 года (утв. Распоряж. Правительства РФ № 1217-р от 03.07.2014 г.). URL: http://government.ru/med ia/files/41d4eeb21a3d62bbd063.pdf (проверено: 15.01.2016).

46. Глобальный инновационный индекс − 2014. ЮНЕСКО. URL: http://www.uis.unesco.org/L ibrary/Documents/global-innovation-index-2014-human-factor-in-innovation-en.pdf (проверено: 21.12.2015).

47. **Bointner R.** Innovation in the energy sector: Lessons learnt from R&D expenditures and patents in selected IEA countries // Energy Policy, 2014, vol. 73, pp. 733−747.

48. **Kimura O.** Public R&D and commercialization of energy-efficient technology: A case study of Japanese projects // Energy Policy, 2010, vol. 38, is. 11, pp. 7358−7369.

VOLKOV Artem A. − Ukhta State Technical University.
169300. Pervomayskaya str. 13. Ukhta. Russia. E-mail: gromadeus@mail.ru

ВОЛКОВ Артем Андреевич − аспирант Федерального государственного бюджетного образовательного учреждения высшего образования «Ухтинский государственный технический университет».
169300, ул. Первомайская д. 13, г. Ухта, Республика Коми. Россия. E-mail: gromadeus@mail.ru

RAZMANOVA Svetlana R. − Gazprom VNIIGAZ, Ukhta Branch Office.
169300. Sevastopolskaya str. 1a. Ukhta. Komi Pepublic. Russia. E-mail: s.razmanova@sng.vniigaz.gazprom.ru

РАЗМАНОВА Светлана Валерьевна − начальник лаборатории экономической эффективности проектов разработки, филиал ООО «Газпром ВНИИГАЗ» в г. Ухта, кандидат экономических наук.
169300, ул. Севастопольская, д. 1а, г. Ухта, Республика Коми, Россия. E-mail: s.razmanova@sng.vniigaz.gazprom.ru

K.S. Movchan

CONTROL SYSTEM OF UTILIZATION OF MEDICAL WASTE: EXPERIENCE OF THE EU AND RUSSIA

К.С. Мовчан

СИСТЕМА УПРАВЛЕНИЯ УТИЛИЗАЦИЕЙ МЕДИЦИНСКИХ ОТХОДОВ: ОПЫТ ЕС И РОССИИ

This article describes the European experience with medical waste processing, as well as presents an analysis of the current situation in this sphere in Russia. Description of the current changes in legislation is followed by the possible strategies for implementation of new methods and schemes in the field of medical waste. This topic is highly important nowadays because medical waste contains a variety of different hazardous and toxic elements that are dangerous for the environment and human health. Moreover, careless treatment of medical waste can affect people and especially children that can unknowingly interact with these objects especially with infectious materials remaining after usage in clinics and hospitals. The author proposes a special scheme for medical waste processing adopting the more sophisticated model of the «resource center» for a smaller scale, in particular, for medical waste. Based on this model it will be possible to improve the existing methods for waste management in this sphere as well as to develop new technologies that can improve environmental and economic aspects in this field.

ORGANIZATION OF MANAGEMENT; DEVELOPMENT STRATEGIES; ENVIRONMENT; MEDICAL WASTE MANAGEMENT; TECHNOLOGY MANAGEMENT.

Рассмотрен опыт европейских государств в сфере обращения с медицинскими отходами, а также приведен анализ текущей ситуации в данной сфере в России. Приводятся описание текущих изменений в законодательстве, а в качестве заключения — возможные пути решения и стратегии по внедрению новых методов в области обращения с медицинскими отходами. Эта тема сегодня очень актуальна, поскольку медицинские отходы содержат различные вредные и токсичные элементы, которые являются опасными для окружающей среды и здоровья человека. Неправильное обращение с медицинскими отходами может оказать негативный эффект на людей и, особенно, детей, которые могут по неосторожности взаимодействовать с данными отходами, особенно с инфекционными материалами, остающимися после использования в клиниках и больницах. Предложена специальная схема для обращения с медицинскими отходами на основании более сложной модели «ресурсного центра», но в меньших масштабах применительно для работы с медицинскими отходами. На основе данной модели можно будет усовершенствовать существующие методы управления отходами в данной сфере, а также разработать новые технологии, которые помогут справиться с экологическими и экономическими проблемами в этой области.

ОРГАНИЗАЦИЯ УПРАВЛЕНИЯ; СТРАТЕГИИ РАЗВИТИЯ; ОКРУЖАЮЩАЯ СРЕДА; МЕДИЦИНСКИЕ ОТХОДЫ; МЕТОДЫ УПРАВЛЕНИЯ; ТЕХНОЛОГИИ УПРАВЛЕНИЯ.

Introduction. Medical waste is generated as a result of actions related to the practice of medicine (including veterinary and dentistry) [6]. Infectious medical waste, according to experts, constitutes 15 % of the waste stream. Many attempts to modernize the system of medical waste management are based solely on waste incineration or other technologies for eliminating waste. This approach has several weaknesses [1]. First, hospitals and other medical facilities are often unable to pay for waste disposal in a special waste incineration plant; as a result, waste of such institutions is either transported to landfill sites or has to be accepted free of charge. Second, many risks arise before the medical waste has reached the incinerator, and their negative impact on the environment is thus not reduced. Therefore, a more comprehensive and alternative strategy for the management of medical waste, involving minimization and segregation is needed. Introducing effective waste segregation systems and their classification based on the assessment of the real threat of infectious waste reduces the amount of medical waste by 3—5 %.

The definition of medical waste. Medical waste, i.e., waste from hospitals and other medical facilities consists of two fractions, of which non-hazardous medical wastes typically constitute 75−90 %. This fraction is comparable to household waste, while the other hazardous medical waste includes all substances that can cause chemical, biological or physical injury. Hazardous medical waste, in turn, also can be divided into several categories: waste that could carry infection, pathological waste, used syringes, pharmaceutical waste, chemical waste and radioactive waste. These categories carry a much greater potential risk to human health than non-hazardous medical waste [2]. There is very little reliable numerical data on the possibility of transfer of contamination from hazardous medical waste to the medical staff or people dealing with such waste, and no data at all concerning the transfer of infection to the population of the surrounding areas. Another group is medical or pharmaceutical waste such as expired household medicines [14].

Environmental problems and risks associated with medical waste. Environmental issues of medical waste are attracting much attention in connection with the increase in the incidence of AIDS and hepatitis, as well as in connection with a potential negative environmental effect from the disposal of this waste in landfills or burning them. Incineration of medical waste releases gets a huge amount of toxic substances, including dioxins and furans, into the air. Incineration emissions also include heavy metals (lead, mercury and cadmium), fine dust, chlorides and other pollutants like products of incomplete combustion (PIC). The resulting combustion products are highly contaminated with ash, which is potentially dangerous for human health. It is scientifically proven that these pollutants can have a serious negative impact on the environment and on the health of people living near special incineration plants. In many countries, hazardous medical waste (needles, etc.) is not separated from the general flow of solid municipal waste, and it can increase the potential risk to the environment and the population living near landfills or other infrastructure for waste management [3]. People traditionally flush expired or unwanted prescribed medicines down the toilet or pour them down the drain. However, this method of disposing of medicines leads to immediate negative environmental effect.

It can cause pollution of sewage, which, in turn, adversely affects groundwater and surface water, fish and vegetation of bodies of water. When the water from these reservoirs is then used for household and drinking needs, it can cause a negative effect on the chemical compounds present in medicines.

EU legislation in the field of medical waste. Legal requirements of the Basel Convention concerning the transboundary movement of hazardous wastes are also applicable to medical waste. The countries that signed the Convention agreed with those principles regulating the transboundary movement of hazardous waste from countries that lack the infrastructure or control measures to allow safe disposal of such waste to those countries with the appropriate infrastructure and controls. Exported waste should be labelled in accordance with the recommended standards. EU Directive on the landfill of waste (1999/31/EC) prohibits disposal of infectious waste of hospitals and other health and veterinary authorities. The EU Directive on the incineration of waste (2000/76/EC) sets out specific limitations on the emission of toxic substance from medical waste incineration, the international Convention for the elimination of persistent organic pollutants (RORB) contains a list of plants for incineration of medical waste, which are among the major sources of dioxin in the environment [13].

The Protocol on persistent organic pollutants was signed by the European Community within the framework of the current EU legislation, setting the legal restrictions on the emission of dioxins and furans in the amount of 0.1 ng/m^2, the toxic equivalent (TE) for installations burning more than 1 tonne of medical waste per hour, as a key principle of the Convention of the UN Economic Commission for Europe (UNECE) on the spread of air pollution in border areas. In 2000, the EU has introduced stricter limits on emissions of toxic substances from incineration of medical waste [4]. This has led to the shutdown of many plants for incineration of medical waste and has increased the number of enterprises for processing infectious health-care waste by other methods.

However, the rate of introducing alternative means of processing medical waste is not quite large and incineration is still the predominant method in Europe. Although incineration is still widely used, other technologies are gaining popularity in Europe. Technologies other than incineration do not produce toxic dioxins and their introduction is consistent with the Stockholm Convention on persistent organic pollutants, which entered into force in May 2004. EU Directive Np2004/27/EU, modernising EU Directive Na2001/83/EC for human medicines, and EU Directive Np2004/28/EU, modernising EU Directive N2001/82/EC concerning veterinary medicines, have established that the environmental impact of drugs should be assessed and special arrangements to limit it should be considered [7].

Scheme of medical waste management in the EU. Eleven member-countries of the EU have systems for collecting medicines, allowing people to return unwanted medicines to the pharmacy. In 2002, only four countries had such a system: Austria, Greece, Ireland and the Netherlands. More than half of the European national systems were governed and funded by the pharmaceutical industry or by pharmacies, the rest is paid by municipalities. There are many differences between such schemes in various countries, including operational principles, funding mechanisms, and capabilities of the systems. In 2002, the European Federation of Pharmaceutical Industries and Association of Pharmacists conducted a review of the existing systems. The main results of the review revealed the following: return of medicines is fully managed and funded by a pharmaceutical network in 5 countries (Belgium, France, Luxembourg, Portugal and Spain). At the same time, pharmacists are involved in the management of such systems, together with private or public contractors in 6 countries (Denmark, Finland, Germany, Italy, Sweden and the UK) [8]. For example, Danish pharmaceutical waste must be deposited at distributed pharmacies. From these collection points, waste is directed to one of the municipal collecting stations, where a final sorting is made before shipment to Kommunekemi (approximately 50%), which is jointly administered by the municipalities, for destruction, neutralization, or storage.

The system can consist of a network of pharmacies, then all the costs are distributed between pharmacies, wholesalers and industry according to their role in the distribution system. The industry is paying for the external costs (mostly incineration), with the exception of Luxembourg, where the pharmaceutical industry does not exist and the Ministry of Environment bears the cost. The system can be controlled by pharmacies and funded by municipalities (Finland, Italy and the UK), or by pharmacists according to the law of producer responsibility (Denmark and Sweden), or only industry (Germany, where manufacturers are required to defer costs associated with the recycling of packaging waste). The system's capabilities are usually limited to expired and unused medicines when the system is financed by pharmacies or municipalities. The industry of these countries should implement the principle of producer responsibility enshrined in national regulations and in the Directive on packaging waste. The system's capabilities for receiving subsidies include packaging (boxes, packages, etc.). The actions are controlled by associations of manufacturers, pharmacies and wholesalers, which have gained a good reputation in countries where the system of reception controls the entire pharmaceutical network. There are no such contact networks in other countries with the exception of the UK where the Association of the British Pharmaceutical Industry (ABP1) supports the existing systems in pharmacies and looks for ways to encourage patients to use such schemes of medical waste disposal [12]. No contacts are scheduled in new EU members because the receiving system operates without funding from the industry. Contacts with national environmental authorities took place in 5 countries, where the return of medicines is funded by the pharmaceutical industry (Belgium, France, Germany, Portugal and Spain), as well as in three other countries (Finland, Luxembourg and the UK). This often leads to the inclusion of the medicine return systems in the closed policy on waste management. Lack of contacts means that the methods for solving the problem are the responsibility of pharmacies for the operation of the systems of medicine return and reflect a lack of relevant legislation in the field of medical waste management. The

European Federation of Pharmaceutical Industries and Association of pharmacists supports the creation of systems for return of expired and unused medicines in the EU, and if possible, the policy on waste management. It has yielded results and these systems operate in pharmacies, serving more than 90% of European consumers. Voluntary policies to promote the medicine return systems involve the development of such systems in countries where they already operate, and cooperation with the national pharmaceutical industry to promote cleaner production, depending on the national policy of waste management [9]. For example, in the Netherlands, special return systems of medicines through pharmacies are no longer needed due to the fact that waste is utilized via modern technologies after it is by consumers. The main conclusion of this section: the return of medicines works in many EU countries. These systems mainly differ by their capabilities for receiving expired and unused medications or stimulating the consumer to return the packaging, and are dependent on funding from the pharmaceutical industry

Legal regulation on the processing of medical waste in Russia. *In accordance with paragraph 1 of article 49 of Federal law no. 323, medical waste includes all types of waste, including anatomical, pathological-anatomical, biochemical, microbiological and physiological waste generated through medical and pharmaceutical activity, manufacturing medicinal products and medical devices, as well as using activators of infectious diseases and genetically modified organisms for medical purposes.*

Paragraph 3 of article 49 of Federal law no. 323-FZ determined that medical waste is subject to collection, use, disposal, placement, storage, transportation, accounting and disposal in a manner prescribed by the legislation in the field of ensuring sanitary and epidemiological welfare of the population [11].

In accordance with the legislation on sanitary and epidemiological welfare of the population, the issues of medical waste management are regulated by SanPiN 2.1.7.2790−10.

According to paragraph 1.2 of SanPiN 2.1.7.2790-10, mandatory sanitary and epidemiological requirements are imposed on:
− handling (collection, interim storage, decontamination, disposal, and transportation)

of waste generated in organizations during medical or pharmaceutical activities, or therapeutic, diagnostic and recreational services (referred to as medical waste);
− location, equipment and operation of the facility for handling of medical waste;
− sanitary and anti-epidemic regime of work when handling medical waste.

Federal law determines the classification of medical waste according to its epidemiological, toxicological, radiation hazard, and also negative impact on the environment by hazard class (A − D):
− class A − epidemiologically safe waste with composition similar to municipal solid waste;
− class B − epidemiologically hazardous waste;
− class − extremely epidemiologically hazardous waste;
− class G − toxicologically hazardous waste that belongs to 1−4 class of danger;
− class D − radioactive waste.

However, the legal foundations of waste production and consumption for preventing harmful impact of waste production and consumption on human health and the environment established by Federal law No. 89 is still under development and will include some additions by the end of 2016.

Possible solutions. One of the possible solutions for the topic of medical waste can be creating a special center for medical waste processing. This organization could be part of the system working with all types of waste generated in a certain area [5]. Though the processing of medical waste has a lot of special procedures, most of them concerned with potentially hazardous and dangerous waste, creating the above-described center for processing this type of waste would be a good way to minimize the environmental pollution.

Creation of the special center for medical waste treatment could solve the existing problems that are appearing in this sphere such as :
− disinfection of household equipment and medical equipment waste is often performed with obsolete methods which are difficult to control and not efficient in epidemiological terms;
− most loading and unloading, transportation within departments, buildings, and constructions, and delivery of waste to local waste containers outside of buildings is done manually;

Center for treatment of medical waste		
Training unit for personnel	Information and Analytic unit	Management unit
Medical organizations		Supply
Utility service organizations, transport organizations		Decontamination
		Transporting
Recycling companies		Utilization, recycling
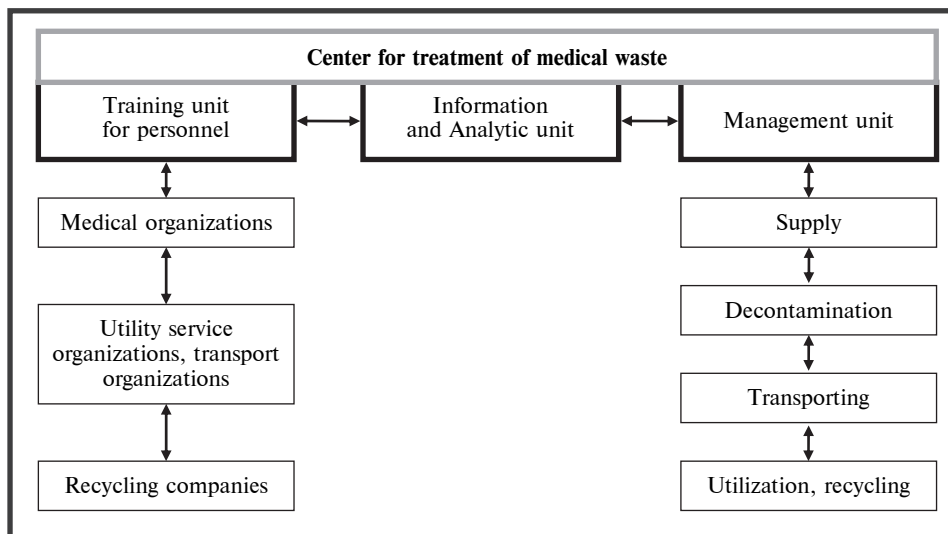
Center for medical waste processing

− current system of irremovable containers without liners and collection of garbage trucks has an outdated design, which causes loss of waste fractions during processing and transportation;

− special waste and household waste is stored together in ordinary landfills. That is creating additional epidemiological and toxicological dangers [10];

− destruction of medical waste which is dangerous in epidemiological and toxicological terms is performed in local hospital boilers and other flawed facilities, and does not provide the necessary hygienic and ecological security;

− staff of medical institutions and patients are not trained to perform the right processing of medical waste;

− lack of necessary instructional and methodological literature, educational visual aids and materials;

Conclusion. In order to develop an effective mechanism for handling medical waste given the requirements of the legislation of the Russian Federation, it is necessary to develop the concept and implement it as a pilot project based on the cluster of the medical and pharmaceutical industry. After implementing this program, it will be possible to calculate the degree of efficiency and to consider the scale of this concept at the regional and federal level.

System for processing medical waste could be a useful instrument for improving the current situation in the environmental sphere and in the sphere of healthcare system as well as for creating additional workplaces.

REFERENCES

1. Medical Waste Management and Disposal, Noyes Data Corporation, 1991.

2. **Alex E.S. Green.** Medical Waste Incineration and Pollution Prevention, 2013.

3. **Frank L. Cross, Jr., Howard D. Hesketh.** Engineering Medical Waste-to-Energy Systems, 2012.

4. **Diane Heminway, Anne Rabe.** Managing medical waste, 1992.

5. **Carl A. Zimring,William L. Rathje.** Encyclopedia of Consumption and Waste: The Social Science of Garbage, 2010.

6. **John Burke Sullivan,Gary R. Krieger.** Clinical Environmental Health and Toxic Exposures, 1999.

7. **Startsev A.A.., Lubarskaya M.A.** Rokovodstvo po upravleniu othodami. SPb.: IUNIDO, 2007. 77 s. (rus)

8. Hospital Waste Management and Its Monitoring, Sanskriti Sharma, 2007.

9. Medical, Municipal and Plastic Waste Management Handbook, Niir Board Of Consultants & Engineers, 2006.

10. Environmental Treatment Technologies for Hazardous and Medical Waste, Subijoy Dutta, 2013.

11. Federal law of 21.11.2011 no. 323-FZ (ed. from 03.07.2016) «About bases of health protection of citizens in the Russian Federation». (rus)

12. URL: http://www.conserve-energy-future.com/medical-waste-disposal.php

13. URL: http://www.medlit.ru/journalsview/gigsan/view/journal/en/2014/issue-6/608-approaches-of-european-and-russian-legislation-in-the-field-of-managem ent-of-medical-waste/

14. URL: http://www.sharpsdisposal.com/what-is-medical-waste/

15. URL: https://www.cdph.ca.gov/certlic/medicalwaste/Pages/default.aspx

СПИСОК ЛИТЕРАТУРЫ

1. Medical Waste Management and Disposal, Noyes Data Corporation, 1991.

2. **Alex E.S. Green.** Medical Waste Incineration and Pollution Prevention, 2013.

3. **Frank L. Cross, Jr., Howard D. Hesketh.** Engineering Medical Waste-to-Energy Systems, 2012.

4. **Diane Heminway, Anne Rabe.** Managing medical waste, 1992.

5. **Carl A. Zimring, William L. Rathje.** Encyclopedia of Consumption and Waste: The Social Science of Garbage, 2010.

6. **John Burke Sullivan, Gary R. Krieger.** Clinical Environmental Health and Toxic Exposures, 1999.

7. **Старцев А.А., Любарская М.А** Руководство по управлению отходами. СПб.: ЮНИДО, 2007. 77 с.

8. Hospital Waste Management and Its Monitoring, Sanskriti Sharma, 2007.

9. Medical, Municipal and Plastic Waste Management Handbook, Niir Board Of Consultants & Engineers, 2006.

10. Environmental Treatment Technologies for Hazardous and Medical Waste, Subijoy Dutta, 2013.

11. Об основах охраны здоровья граждан в Российской Федерации : Федер. закон № 323-ФЗ от 21.11.2011 г. (ред. от 03.07.2016 г.).

12. URL: http://www.conserve-energy-future.com/medical-waste-disposal.php

13. URL: http://www.medlit.ru/journalsview/gigsan/view/journal/en/2014/issue-6/608-approaches-of-european-and-russian-legislation-in-the-field-of-management-of-medical-waste/

14. URL: http://www.sharpsdisposal.com/what-is-medical-waste/

15. URL: https://www.cdph.ca.gov/certlic/medicalwaste/Pages/default.aspx

MOVCHAN Konstantin S. — Deputy director for international raltions in «XXI century. Medical and pharmaceutical projects». Master of science in material flow management.

191024. Nevsky av. 146. Lit. A. St. Petersburg. Russia. Tel.: 8(812)240-35-55.

МОВЧАН Константин — заместитель директора по международным отношениям «Союза в сфере обращения лекарственных средств и медицинской техники. Медико-фармацевтические проекты XXI век». Магистр по специальности «Управление материальными потоками».

191024, Невский пр., д. 146, лит. А, Санкт-Петербург, Россия. Тел.: 8(812)240-35-55.

A.A. Aletdinova

INNOVATIVE DEVELOPMENT OF THE AGRO-INDUSTRIAL COMPLEX ON THE BASIS OF DISRUPTIVE TECHNOLOGIES

А.А. Алетдинова

ИННОВАЦИОННОЕ РАЗВИТИЕ АГРОПРОМЫШЛЕННОГО КОМПЛЕКСА НА ОСНОВЕ ПРОРЫВНЫХ ТЕХНОЛОГИЙ

Technological progress has led to the emergence of new disruptive technologies: mobile Internet, artificial intelligence, Internet of things, cloud technology, advanced robotics, autonomous and semi-autonomous vehicles, next-generation genomics, energy storage, 3D printing, advanced materials, renewable energy, exploration, advanced oil and gas exploration and recovery. In the author's opinion, implementing most of them in the agro-industrial complex (AIC) should be considered promising. These technologies will provide a way out of crisis in the cluster, as well as innovative development, radically transforming the agricultural sector. They are expected to contribute to the increment of scientific, labor, environmental, information, communication, and social potentials. They are expected to improve technical equipment, develop industrial and social infrastructures. They are also supposed to contribute to the saving of natural resources. The article describes the main emerging potentials for innovative development of the agro-industrial complex on the basis of disruptive technologies. The massive use of these technologies should allow to reduce the cost of their implementation. The author sees the future of this cluster as an innovative and high-tech one, capable of ensuring food and national security. The agricultural production should be boosted through creating a unified information and communication system for remote economic management and social welfare, logistics, consulting services, education, and public services; robotics and automation of technological processes; genetic industry; the use of new technologies, materials, renewable energy, all of which would ultimately lead to a more harmonious interaction of man and biosphere. In the future the agro-industrial cluster is seen as innovative and high-tech, capable of ensuring food and national security.

INNOVATIVE DEVELOPMENT; DISRUPTIVE TECHNOLOGIES; AGRICULTURE; INTENSIFICATION OF PRODUCTION; POTENTIAL EFFECT OF INTRODUCTION.

Научно-технический прогресс привел к появлению новых прорывных технологий: мобильного интернета, искусственного интеллекта, интернета вещей, облачных технологий, прогрессивных роботов, автономных и полуавтономных транспортных средств, генной индустрии, аккумулирования и накопления энергии, 3-D печати, материалов нового поколения, возобновляемой энергии, разведки, добычи и восполнения нефти и газа. Следует считать перспективным использование большинства из них в агропромышленном комплексе. Они обеспечат не только выход из кризиса этого кластера, но и инновационное развитие, кардинально преобразив аграрную сферу. Ожидается приращение научного, экологического, информационно-коммуникационного потенциалов, повышение технической оснащенности, развитие производственной и социальной инфраструктуры, сохранение природного потенциала. Первоначальное снижение трудового и социального потенциалов за счет отмирания ряда профессий, сокращения низкоквалифицированных работников и обострения их социальной незащищенности должно компенсироваться улучшением качества жизни и труда, востребованностью специалистов новых для агропромышленного комплекса специальностей, повышением производительности труда. В будущем эти потенциалы тоже будут расти. Рассмотрены основные появляющиеся резервы инновационного развития агропромышленного комплекса на основе прорывных технологий. Массовое использование этих технологий должно позволить снизить стоимость их внедрения. Переход к интенсификации аграрного производства на основе создания единой информационно-коммуникационной системы дистанционного управления хозяйственной деятельностью и социального обеспечения, логистики, консультационных служб, образования, государственных услуг, роботизации и автоматизации технологических процессов, генной индустрии, использования новых технологий, материалов, возобновляемой энергии реализует гармоничное взаимодействие человека и биосферы. В перспективе агропромышленный кластер видится инновационным и высокотехнологичным, способным обеспечить продовольственную и национальную безопасность.

ИННОВАЦИОННОЕ РАЗВИТИЕ; ПРОРЫВНЫЕ ТЕХНОЛОГИИ; АГРОПРОМЫШЛЕННЫЙ КОМПЛЕКС; ИНТЕНСИФИКАЦИЯ ПРОИЗВОДСТВА; ПОТЕНЦИАЛ; ЭФФЕКТ ОТ ВНЕДРЕНИЯ.

Introduction. The agro-industrial complex is a cluster which is characterized by the presence of groups of geographically accumulated enterprises with a common specialization, a network of research and educational organizations and a common social environment. In our view, the agro-industrial cluster is a stable network of interacting economic agents which is able to meet the needs of the growing population for high-quality food products based on introducing innovations.

Let us look at the self-definitions of two centers of cluster development in the Novgorod and Kemerovo regions. The agro-industrial cluster in the Novgorod region is a broad partnership, a mobile structure of the most active organizations of the economy in the Novgorod region, created to enhance their competitiveness and economic potential through effective cooperation in the production, processing, transportation, promotion, sales and the provision of consulting and educational services, by means of organizing a regulated flow of information processes between them [1]. The agro-industrial cluster in the Kemerovo region is a voluntary and informal association of organizations from different sectors, geographically concentrated in one region, which was created with the aim of production, processing and sales of agricultural products and protection of the environment [2]. They are quite different and they have different functions.

Driven by economical and structural, social, environmental, natural-resource, political institutional, technological and other needs and in accordance with the «Forecast of scientific and technological development of the Russian agro-industrial complex until 2030» [3], the agro-industrial complex is being transformed into an innovation-oriented cluster. If we are talking about the development of the agricultural cluster, it is necessary to describe the qualitative changes in its structure and components. Economic growth is characterized by quantitative changes of the main indicators of the agricultural sector, whereas its development is marked by qualitative changes, based on innovative activities.

Science and technological progress, human activities, political confrontations change the vision of the future. There are changes in the population structure, middle class is shrinking, online public services are starting to develop.

Society, commerce, and social interaction are being transferred to a virtual integrated space; nano-materials are being developed, 3D printing, robotization and intellectualization of technological processes are being introduced; the service industry is expanding, knowledge is becoming the most important resource of the economy. There are uprising global talents, as well as the growing threat of climate changes, hunger, threats to national security, environmental pollution, energy crisis, increasing side effects of technological development; the process of globalization is continuing. The identified trends require the society to take measures to strike a balance between human activities and the environment; to prevent economic, political, technological, social crises; to meet the needs of society. This is only possible through technological (process, product), marketing, organizational, ecological and social innovations [1].

The exhaustibility of resources required that Russia should make a transition from a resource-based economy to an innovative one. The issues of this transition in the agricultural sector were studied by A.V. Babkin, M.S. Bunin, A.S. Donchenko, B.D. Dokin, O.V. Yolkin, A.L. Nefyodov, O.S. Nogovicina, P.M. Petruskkevitch, I.P. Petruskkevitch, G.S. Prokopyev, T.M. Ryabukhina, A.L. Eidis and other researchers [5, 6, 7, 8, 9, 10].

The complex structure of the agricultural cluster requires using all types of innovation for its modernization. The innovations provide the intensification of production at a new level, the reconstruction of the social infrastructure, sustainable development.

The purpose of this study is in determining the main effects of introducing disruptive technologies in agriculture.

Modern state of the agro-industrial complex. The agro-industrial complex (AIC) is the backbone cluster of the Russian economy which forms the agricultural market, economic, social and employment potentials of rural areas, ensuring food and economic security.

Currently, it requires serious reformation and modernization. Power supply of agricultural organizations in Russia has been gradually decreasing. In comparison with 2000, it decreased by more than 1.5 times, which does not make it possible to go to intensive

production [11]. The average service life of machinery, vehicles and equipment in agriculture is significantly below the same indicators in the manufacturing industry, electric power industry, gas and water industries, as well as in the whole economy [11]. In addition, the renovation rate of vehicle and tractor stock does not allow modernizing it. For example, as of January 1, 2014, the share of the agricultural equipment older than ten years in the Novosibirsk region accounted for 83.2 % of the tractors, 68.0 % of the combine harvesters , 43.0 % of the forage harvesters and 93.8 % of the tractor trailers [12]. The nationwide situation is no better. Unfortunately, the indicators of technical and technological renovation of agricultural machinery stock totaled 57−64 % of the values from the State Program plan of 2008−2012 [13].

A power supply for 100 acres of sown area has an average value of 167.01 horsepower, whereas the required value is 300−350 horsepower. The availability of agricultural tractors and harvesting machines is achieved only by 45−60 %. Studies have shown that the optimal vehicle and tractor stock should comprise 850−900 thousand tractors for developing 30 million hectares of abandoned land or 630 thousand tractors for cultivating the existing one with an average power of 200 hp, 200−250 thousand combine harvesters and 60 thousand forage harvesters [14]. According to Nemtsov, the technical potential of the agro-industrial complex is still on the decrease [15]. The national average degree of wear of fixed assets at the end of the year amounts to 47.7 %, while in agriculture this figure is slightly lower (42.5 %), but still not low enough. Zhablin, analyzing the state of agriculture, draws attention to the decrease of human resources and productive capacities by half and the reduction of the remaining capacities by 3−4 times, so that infrastructure indicators are fixed at the level of the 1990s [16].

In recent times the number of scientific research institutes personnel has been reduced, design offices and laboratories, experimental farms have been disbanded and redesigned. The average age of researchers gives rise to concern [17]. It should be also kept in mind that human capital tends to decline, because of the limited lifespan that may affect the scientific potential of the country.

In this situation, the agro-industrial complex (AIC) requires state support for reconstruction of institutions, infrastructural, technical, human and other resources. At the present time, the 'Strategy for socio-economic development of the agro-industrial complex of the Russian Federation for the period until the 2020' and 'Strategy for sustainable development of rural territories of the Russian Federation for the period up to 2030' have been developed in order to modernize the agricultural sector [18, 19]. Their main innovative aspects are reflected in the following tasks:
− creating the conditions for soil fertility preservation and restoration, development of agricultural land melioration;
− increasing the effectiveness of internal and external agricultural, commodity and food markets regulation;
− technical and technological modernization, encouragement of investments and innovative development of the agro-industrial complex;
− creation of organizational and economic conditions for expanded reproduction;
− improvement of an information system in the agro-industrial complex;
− scientific support for the implementation of measures for the development of agricultural production and agricultural, commodity and food markets regulation;
− improving governance in the field of agriculture;
− increasing employment, level and quality of life of the rural population.

State support of the agro-industrial complex is carried out within the framework of the 'State Program for Development of Agriculture and Regulation of Agricultural Commodities Markets in 2013−2020' in the form of subsidies from the Federal budget to the budgets of the subjects of the Russian Federation [20]. Their basic forms, aimed at innovative development, are shown in Tab. 1.

The greatest support is provided for integrated development of social and engineering infrastructure objects, the construction and reconstruction of roads in the rural area. Within this Program there are no subsidies to agricultural machinery producers and for the implementation of innovative projects, which generally hampers innovative development.

Table 1

State support of innovative development of agro-industrial complex as of 30.12.2015
|(compiled based on the data from [21])

Directions of state support	Provided in the current year, thousand rubles
Subsidies for partial compensation of the direct costs incurred for creating and upgrading the agro-industrial complex	1564633
Subsidies to producers of agricultural machinery	−
Subsidies for implementing promising innovative projects of the agro-industrial complex	−
Subsidies for integrated development of social and engineering infrastructure objects in the settlements located in the rural area, the construction and reconstruction of roads	9361719
Subsidies to support local initiatives of citizens living in rural areas	144459
Subsidies for construction, reconstruction, technical re-equipment of irrigation and drainage systems for general and individual use and separately located waterworks belonging to agricultural producers	1950700

The producers are wary of new technologies and innovations. According to the statistical study of the agricultural organizations of the Novosibirsk region (with a sample size of 53 farms) the main factors hindering innovation are the lack of own funds, high cost of innovation and the degree of risk [9].

Thus, the agro-industrial complex requires serious reformation and modernization. This is impossible without technical re-equipment. The only possible way to pull the cluster out of the crisis is through innovation with the support from agricultural producers and the state.

Prospects for application of disruptive technologies in the agro-industrial complex. Disruptive technologies are achievements 'which transform life, business and the global economy'. They contribute to wide-scale economic reforms and breakthroughs over the next years [22]. Currently, there are twelve most important technologies:

1) mobile Internet;
2) artificial intelligence;
3) Internet of things;
4) cloud;
5) advanced robotics;
6) autonomous and semi-autonomous vehicles;
7) next-generation genomics;
8) energy storage;
9) 3D printing;
10) advanced materials;

11) advanced oil and gas exploration and recovery;
12) renewable energy, i.e.,solar and wind [17].

McKinsey & Company estimated that the global economic effect from implementing these technologies is expected to be between $14 trillion and $33 trillion a year in 2025 (Tab. 2).

Table 2

Potential economic impact in 2025 from the implementation of disruptive technologies
(based on the data of [22]), trillion $

Disruptive technologies	Economic effect
Mobile Internet	3.7−10.8
Artificial intelligence	5.2−6.7
Internet of things	2.7−6.2
Cloud	1.7−6.2
Advanced robotics	1.7−4.5
Autonomous and semi-autonomous vehicles	0.2−1.9
Next-generation genomics	0.7−1.6
Energy storage	0.1−0.6
3D printing	0.2−0.6
Advanced materials	0.2−0.5
Advanced oil and gas exploration and recovery	0.1−0.5
Renewable electricity (wind and solar)	0.2−0.3

In Russia, the share of expenditures on disruptive technologies amounts to 2.5 % − 7 % of the total expenditures on science [23]. This is one of the reasons why the targets of the Innovative Development Strategy for the period until 2020 have not been achieved yet.

It should be noted that eleven out of twelve of the abovementioned technologies can be applied to the agricultural sector. On the one hand, the agro-industrial complex should be seen as a strategically important cluster in terms of national and food security, while on the other hand, in perspective it can be a highly technological and innovative one. In foreign publications there is a term 'smart agriculture', that means that agriculture is seen as a highly technological cluster, introducing innovations which include the smart generation of agricultural machinery [24].

According to the 'Strategy of socio-economic development of the agro-industrial complex of the Russian Federation for the period until 2020', it is intended to create a system of efficient, competitive producers on the basis of market mechanisms for improving state agricultural policyusing the mechanism of creating the national innovation system [18].

The agro-industrial cluster can turn into a high-tech one through implementing disruptive technologies. Mobile Internet will provide wireless Internet access based on the WAP Protocol, and, therefore, remote control, network interaction based on the models: C2M, M2S, M2M, C2B, B2C, C2C, B2B, C2A, A2C, A2A, C2G, G2C, G2G, A2B, B2A, A2G, G2A B2G, G2B, M2B, B2M, M2A, A2M, M2G, and G2M (interaction between consumers, business, government and municipal authorities, intellectual, automated systems, and within these groups). Artificial intelligence will increase software and technical support for information and communication technology equipment (ICT) in organizations and households and for a new generation of robots. For control and automation of the production processes, artificial intelligence, Internet of things, cloud technology should be applied. Robotic tools, robotic systems and devices will ultimately displace human labor in agricultural machinery industry, enterprises and organizations servicing, agriculture, food processing industries, forestry, water sector and fisheries [25]. There will be autonomous technical vehicles with automated control systems and computer vision. Genetic industry will ensure the creation of ethanol, biodiesel from conventional organisms (for example Escherichia coli), manipulation of genes to increase productivity of crops, livestock, forestry and fisheries.

New technologies of energy generation and storage will improve the performance of power lines, which is important for the entire infrastructure of AIC, for electrical devices to function, especially in greenhouses; it is necessary to use renewable sources of energy (for example wind, solar). Circumferential devices for creating physical objects by printing successive layers of materials using 3D digital models, new composite materials may find application in the agricultural machinery industry.

In the Orel region, the GLONASS cluster was created with the aim of development and introduction of new advanced technologies. In 2015, Russian Space Systems presented information and communication technologies for precision farming. They help to reduce costs by 30 % due to the automation of business processes, control over the use of agricultural land and the targeted use of transport. The connection of a vehicle to the GLONASS system allows to control its movements, automatically model economically profitable routes, provide fully automated operation, get quick information about fulfilled tasks, synchronize it with information systems and get its analyses for any period of operation [26]. The first domestically built agricultural unmanned vehicle that performs plant monitoring and spraying was created in the same year [26].

Robotic technology has been developed for several years. The Russian Cognitive Technologies company was the first to develop a prototype of an unmanned tractor. It is equipped with a computer vision system that can detect objects as small as 10-15 cm at a distance of up to 15-20 m [27]. The All-Russian Research Institute for Mechanization in Agriculture (VIM) has become the leading scientific center developing agricultural robots in Russia. Its researchers regularly participate in agricultural exhibitions showing their inventions. Yet, as noted by Ananiev, the use of agricultural robots is considered to be cost effective only if it replaces at least two employees with its full depreciation period equal to three years [28].

Main effects of introducing disruptive technologies in AIC

№	Potentials for innovative development	Effect from introducing new technologies
1	Scientific potential	Demand for scientists and specialists of new professions emerging at the intersection of different scientific fields Diffusion of knowledge Development and creation of new research and experimental design centers and laboratories
2	Labor potential	Decrease in the number of employees Disappearance of a number of professions such as mechanic, milker, etc. Precarization of low qualified personnel labor Growing requirements for employees competences Use of various forms of smart education Employees having a good command of ICT skills Better working conditions Growth of labor productivity
2	Technical equipment	Automation and intellectualization of technological processes Good technical equipment not only for individual operations but also for all technological cycles
3	Environmental and ecological potentials	Resource conservation Less impact (mechanical, chemical, etc.) on the environment Less space needed for economic activities Conservation of animals and plants population
4	Infrastructure development	Emergence of smart infrastructures of production and the social sphere, smart settlements
5	Information and communications potential	Creating a unified network of information support of management Development of various forms of network interaction Increase of information literacy of the population Growth of information security threats
6	Social potential	Meting the needs of the population Hunger problem solution Improvement of the quality of life

The economic effect of systematic introduction of disruptive technologies to the agro-industrial complex is expected to be positive in the form of increased yields, productivity and profit. Other effects can also be expected (Tab. 3).

As we see it, disruptive technologies as innovations not only change the production process itself, but also improve scientific, environmental, natural, information and communication potentials, develop technical equipment and upgrade infrastructure. An ambiguous situation prevails in the structure of labor and social potentials. On the one hand, skilled labor is highly required, however, a number of professions will become unnecessary which will lead to a reduction of employees in the AIC and to a further decline of their numbers, and hence of social vulnerability of certain segments of the population, mostly rural. It is necessary to say that the transformation of the agricultural cluster in the high-tech sector, the appearance of smart settlements will attract new high qualified professionals with a wide range of skills to villages. Thus, after the introduction of disruptive technologies to agriculture and the appearance of new professions, labor and social potentials will begin to recover and grow.

Conclusion. The situation in the agro-industrial complex requires adopting measures allowing for economic recovery of the cluster.

With the threat of economic, political, technological crises it is not enough just to ensure economic growth in the agricultural sector. Production intensification requires innovative development. In our opinion, the future lies in promising disruptive technologies, providing new development opportunities that transform the AIC into a high-tech sector of the economy.

The results of the study.

1. People change the vision of the future. There are growing threats of climate change, hunger, threats to national security, danger of environmental pollution, energy collapse, as well as unwanted side effects of technology development. The process of globalization is never-ending. The only way to solve these problems is through innovations. In our opinion, they should be associated with the introduction of disruptive technologies: mobile Internet, artificial intelligence, Internet of things, cloud technology, advanced robotics, autonomous and semi-autonomous vehicles, advanced genomics, energy storage, 3D printing, advanced materials, renewable energy, advanced oil and gas exploration and recovery.

2. These technologies (except for the last) can be used for developing the agro-industrial complex. There are already examples of their development and application. The analysis of statistical data shows that agriculture is in a deep crisis. The targets planned in 'The Program of technical and technological updating of agricultural machinery stock' have not been achieved. Technological, social and industrial infrastructures are in need of modernization. Disruptive technologies can not only provide that, but also form a high-tech and innovative cluster.

3. In our view, the implementation of these technologies will provide the following effects. For scientific potential: there will be an increasing demand for scientists and specialists of new professions emerging at the intersection of different fields of science; the diffusion of knowledge; the development and creation of new research and design centers and laboratories. For the labor potential: the number of workers involved in the agro-industrial complex will be reduced; some occupations (such as mechanic, milker, etc.) will stop to exist, while new ones will appear; the employment of low-skilled personnel will become precarious; the requirements for the personnel skills will be increased; various forms of smart education will be used; employees will have a good command of ICT skills; working conditions will be improved; productivity will grow. For technical equipment: technological processes will be automated and intellectualized; there will be full mechanization of not only individual operations, but also all technological cycles. For environmental and natural potentials: there will be resource conservation; reduced impacts on the environment (mechanical, chemical, etc.); less space will be needed for economic activities; the population of plants and animals will be preserved. For infrastructure development: there will be smart infrastructures for production and the social sphere as well as smart settlements. For the information and communication potential: a unified network of information support for management will be created; various forms of network interaction will be developed; there will be an increase in information literacy as well as increased cases of threats to information security. For social potential: the needs of the population will be met; the problem of hunger will be solved; the quality of life will be improved.

4. The introduction of disruptive technologies in the agricultural sector cannot be done only by efforts of agricultural producers. There is a need of highlevel information and communication support for organizations and households to create a single well-developed information and communication system of the agro-industrial complex, including subsystems for remote control of all structural subdivisions of the AIC, logistics, smart settlements, consulting and public services. This requires a development of a state program and a large amount of investment. It is necessary to assume that mass use of advanced technologies allows to reduce the cost of their implementation in organizations and households.

The direction for further research is seen in the assessment of the contribution that disruptive technologies make to scientific, labor, environmental, natural, information and communication potentials; to the new production, technical, and social infrastructure which form the innovative development of the agro-industrial complex.

REFERENCES

1. Agropromyshlennyi klaster Kemerovskoi oblasti. URL: http://agrobuy.ru/agrocluster42 (data obrashcheniia: 19.07.2016). (rus)

2. Agropromyshlennyi klaster Novgorodskoi oblasti. URL: http://ckr53.ru/clusters/924/ (data obrashcheniia: 25.08.2016). (rus)

3. Prognoz nauchno-tekhnologicheskogo razvitiia agropromyshlennogo kompleksa Rossii na period do 2030 goda: global'nye vyzovy. *Agrarnyi pul's velikoi strany: informatsionnyi biulleten'*. 2016. № 4. S. 14—21. (rus)

4. **Aletdinova A.A.** Statisticheskoe issledovanie innovatsionnoi deiatel'nosti organizatsii: monogr. Novosibirsk: Izd-vo NGTU, 2011. 272 s. (rus)

5. **Babkin A.V., Nogovitsyna O.S.** Teoretiko-methodological aspects of the estimation of efficiency of the innovative infrastructure of the industrial complex of region. *St. Petersburg State Polytechnical University Journal. Economics*, 2012, no. 1(139), pp. 56—61. (rus)

6. **Bunin M.S., Nefedov B.A., Eidis A.L.** Upravlenie innovatsionnymi protsessami v agropromyshlennom komplekse. M.: Rosinformagrotekh, 2006. 295 s. (rus)

7. **Donchenko A.S., Pershukevich P.M.** Osnovnye napravleniia innovatsionnogo razvitiia sel'skogo khoziaistva Sibiri. *Dostizheniia nauki i tekhniki APK*. 2016. T. 30. № 2. S. 5—10. (rus)

8. **Dokin B.D., Elkin O.V.** Tekhnologicheskaia i tekhnicheskaia modernizatsiia rastenievodstva Sibiri. *Ekonomika sel'skokhoziaistvennykh i pererabatyvaiushchikh predpriiatii*. 2015. № 1. S. 18—22. (rus)

9. **Pershukevich I.P., Riabukhina T.M.** Mekhanizm innovatsionnogo razvitiia agropromyshlennykh formirovanii Sibiri. *Fundamental'nye issledovaniia*. 2015. № 12—5. S. 1036—1040. (rus)

10. **Prokop'ev G.S.** Metodologiia proektirovaniia innovatsionnykh formirovanii v sel'skom khoziaistve. *RISK: Resursy, Informatsiia, Konkurentsiia*. 2010. № 4. S. 184—192. (rus)

11. Sait Federal'noi sluzhby gosudarstvennoi statistiki. URL: http://www.gks.ru/ (data obrashcheniia: 19.05.2016). (rus)

12. **Nemtsov A.E., Korotkikh V.V.** Tekhnika trebuet obnovleniia. *Innovatsii — prioritetnyi put' razvitiia agropromyshlennogo kompleksa*: sb. mater. VIII Mezhdunar. nauch.-prakt. konf. Kemerovo: Kemerov. GSKhI, 2009. 284 s. (rus)

13. **Kuz'min V.N.** Razrabotka programm tekhnicheskogo osnashcheniia sel'skogo khoziaistva v rynochnoi ekonomike. M.: FGBNU «Rosinformagrotekh». 2014. 304 s. (rus)

14. **Fedorenko V.F.** Povyshenie resursoenergoeffektivnosti agropromyshlennogo kompleksa. M.: FGBNU «Rosinformagrotekh». 2014. 284 s. (rus)

15. **Nemtsov A.E.** Tekhnika — osnova razvitiia agropromyshlennogo kompleksa. *Innovatsii i prodovol'stvennaia bezopasnost'*. 2015. № 2(8). S. 60—64. (rus)

16. **Zhalnin E.V.** Agropromyshlennyi kompleks Rossii — stagnatsiia ili razvitie? *Traktory i sel'khozmashiny*. 2012. № 7. S. 3. (rus)

17. **Aleksandrova A.V., Androsenko N.V., Basareva V.G., Bakhmutskaia A.V., Borisov A.A., Vertakova Iu.V., Volkova A.A., Glukhov V.V.** i dr. Ekonomika i promyshlennaia politika: teoriia i instrumentarii : koll. monogr. Pod red. d-ra ekon. nauk, prof. A.V. Babkina. SPb.: Izd-vo SPbGPU, 2014. 612 s. (rus)

18. Strategiia sotsial'no-ekonomicheskogo razvitiia agropromyshlennogo kompleksa Rossiiskoi Federatsii na period do 2020 goda (nauchnye osnovy). M.: RASKhN. 2011. 101 s. URL: http://www.vniiesh.ru/documents/document_9509_%D0%A1%D1%82%D1%80%D0%B0%D1%82%D0%B5%D0%B3%D0%B8%D1%8F%20%D0%90%D0%9F%D0%9A%202020.pdf (data obrashcheniia: 08.07.2016). (rus)

19. O ustoichivogo strategii razvitiia sel'skikh territorii RF na period do 2030 g.: Rasporiazh. Pravitel'stva RF № 151-r ot 02.02.2015 g. URL: http://government.ru/media/files/Fw1kbNXVJxQ.pdf (data obrashcheniia: 30.07.2016). (rus)

20. Informatsionnyi spravochnik o merakh i napravleniiakh gosudarstvennoi podderzhki agropromyshlennogo kompleksa RF. URL: http:// www.gp.specagro.ru/ (data obrashcheniia: 03.08.2016). (rus)

21. Informatsionnyi spravochnik o merakh i napravleniiakh gosudarstvennoi podderzhki agropromyshlennogo kompleksa RF. URL: http://www.gp.specagro.ru/region/rf/30/12/2015 (data obrashcheniia: 03.08.2016). (rus)

22. **Manyika J. Chui M., Bughin J., Dobbs R., Bisson P., Marrs A.** Disruptive technologies: advances that will transform life, business, and the global economy. McKinsey Global Institute, 2013. URL: http://www.mckinsey.com/business-functions/business-technology/our-insights/disruptive-technologies (accused July 12, 2016).

23. Rossiiskii innovatsionnyi indeks, Pod red. L.M. Gokhberga. M.: Vysshaia shkola ekonomiki, 2011. 84 s. (rus)

24. Enabling Smart Farming in Europe. URL: http://www.cema-agri.org/page/enabling-smart-farming-europe (accused June 13, 2016).

25. **Aletdinova A.A.** Diffuziia smart-tekhnologii kak paradigma perekhoda k sed'momu tekhnologicheskomu ukladu. *Teoriia ustoichivogo razvitiia ekonomiki i promyshlennosti*. Pod red. A.V. Babkina. SPb.: Izd-vo Sankt-Peterburgskogo politekhn. un-ta Petra Velikogo, 2016. S. 55—77. (rus)

26. Orlovskaia oblast' i Belarus' obsuzhdaiut

razvitie proektov GLONASS dlia sel'skogo khoziaistva. *Novosti internet veshchei.* URL: https://iot.ru/selskoe-khozyaystvo/2808orlovskaya_oblasts_i_belaruss_obsuz hdaut_razvitie_proektov_glonass_dlya_selsskogo_hozy ajstva (data obrashcheniia: 20.09.2016). (rus)

27. Pervyi prototip samoupravliaemogo traktora predstavlen v Kazani. *Novosti internet veshchei.* URL:

https://iot.ru/selskoe-khozyaystvo/prototip-pervogo-sam oupravlyaemogo-traktora-predstavlen-v-kazani (data obrashcheniia: 20.09.2016). (rus)

28. **Anan'ev A.N.** Problemy primeneniia robotov v sel'skokhoziaistvennom proizvodstve. URL: http://www.biz-for.ru/robotics/robotsprobl/robotsprobl.php (data obrashcheniia: 18.08.2016). (rus)

СПИСОК ЛИТЕРАТУРЫ

1. Агропромышленный кластер Кемеровской области. URL: http://agrobuy.ru/agrocluster42 (дата обращения: 19.07.2016).

2. Агропромышленный кластер Новгородской области. URL: http://ckr53.ru/clusters/924/ (дата обращения: 25.08.2016).

3. Прогноз научно-технологического развития агропромышленного комплекса России на период до 2030 года: глобальные вызовы // Аграрный пульс великой страны: информационный бюллетень. 2016. № 4. С. 14—21.

4. **Алетдинова А.А.** Статистическое исследование инновационной деятельности организации: моногр. Новосибирск: Изд-во НГТУ, 2011. 272 с.

5. **Бабкин А.В., Ноговицына О.С.** Научно-методологические аспекты оценки эффективности инновационной инфраструктуры промышленного комплекса региона // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2012. № 1(139). С. 56—61.

6. **Бунин М.С., Нефедов Б.А., Эйдис А.Л.** Управление инновационными процессами в агропромышленном комплексе. М.: Росинформагротех, 2006. 295 с.

7. **Донченко А.С., Першукевич П.М.** Основные направления инновационного развития сельского хозяйства Сибири // Достижения науки и техники АПК. 2016. Т. 30. № 2. С. 5—10.

8. **Докин Б.Д., Ёлкин О.В.** Технологическая и техническая модернизация растениеводства Сибири // Экономика сельскохозяйственных и перерабатывающих предприятий. 2015. № 1. С. 18—22.

9. **Першукевич И.П., Рябухина Т.М.** Механизм инновационного развития агропромышленных формирований Сибири // Фундаментальные исследования. 2015. № 12—5. С. 1036—1040.

10. **Прокопьев Г.С.** Методология проектирования инновационных формирований в сельском хозяйстве // РИСК: Ресурсы, Информация, Конкуренция. 2010. № 4. С. 184—192.

11. Сайт Федеральной службы государственной статистики. URL: http://www.gks.ru/ (дата обращения: 19.05.2016).

12. **Немцов А.Е., Коротких В.В.** Техника требует обновления // Инновации — приоритетный путь развития агропромышленного комплекса: сб.

матер. VIII Междунар. науч.-практ. конф. Кемерово: Кемеров. ГСХИ, 2009. 284 с.

13. **Кузьмин В.Н.** Разработка программ технического оснащения сельского хозяйства в рыночной экономике. М.: ФГБНУ «Росинформагротех». 2014. 304 с.

14. **Федоренко В.Ф.** Повышение ресурсоэнергоэффективности агропромышленного комплекса. М.: ФГБНУ «Росинформагротех». 2014. 284 с.

15. **Немцов А.Е.** Техника — основа развития агропромышленного комплекса // Инновации и продовольственная безопасность. 2015. № 2(8). С. 60—64.

16. **Жалнин Э.В.** Агропромышленный комплекс России — стагнация или развитие? // Тракторы и сельхозмашины. 2012. № 7. С. 3.

17. **Александрова А.В., Андросенко Н.В., Басарева В.Г., Бахмутская А.В., Борисов А.А., Вертакова Ю.В., Волкова А.А., Глухов В.В.** и др. Экономика и промышленная политика: теория и инструментарий : колл. моногр. / под ред. д-ра экон. наук, проф. А.В. Бабкина. СПб.: Изд-во СПбГПУ, 2014. 612 с.

18. Стратегия социально-экономического развития агропромышленного комплекса Российской Федерации на период до 2020 года (научные основы). М.: РАСХН. 2011. 101 с. URL: http://www.vniiesh.ru/documents/document_9509_%D0%A1%D1%82%D1%80%D0%B0%D1%82%D0%B5%D0%B3%D0%B8%D1%8F%20%D0%90%D0%9F%D0%9A%202020.pdf (дата обращения: 08.07.2016).

19. О устойчивого стратегии развития сельских территорий РФ на период до 2030 г.: Распоряж. Правительства РФ № 151-р от 02.02.2015 г. URL: http://government.ru/media/files/Fw1kbNXVJxQ.pdf (дата обращения: 30.07.2016).

20. Информационный справочник о мерах и направлениях государственной поддержки агропромышленного комплекса РФ. URL: http://www.gp.specagro.ru/ (дата обращения: 03.08.2016).

21. Информационный справочник о мерах и направлениях государственной поддержки агропромышленного комплекса РФ. URL: http://www.gp.specagro.ru/region/rf/30/12/2015 (дата обращения: 03.08.2016).

22. **Manyika J. Chui M., Bughin J., Dobbs R., Bisson P., Marrs A.** Disruptive technologies: advances

that will transform life, business, and the global economy. McKinsey Global Institute, 2013. URL: http://www.mckinsey.com/business-functions/business-technology/our-insights/disruptive-technologies (accused July 12, 2016).

23. Российский инновационный индекс / под ред. Л.М. Гохберга. М.: Высшая школа экономики, 2011. 84 с.

24. Enabling Smart Farming in Europe. URL: http://www.cema-agri.org/page/enabling-smart-farming-europe (accused June 13, 2016).

25. **Алетдинова А.А.** Диффузия smart-технологий как парадигма перехода к седьмому технологическому укладу // Теория устойчивого развития экономики и промышленности / под ред. А.В. Бабкина. СПб.: Изд-во Санкт-Петербургского политехн. ун-та Петра Великого, 2016. С. 55—77.

26. Орловская область и Беларусь обсуждают развитие проектов ГЛОНАСС для сельского хозяйства // Новости интернет вещей. URL: https://iot.ru/selskoe-khozyaystvo/2808orlovskaya_oblasts_i_belaruss_obsuzhdaut_razvitie_proektov_glonass_dlya_selsskogo_hozyajstva (дата обращения: 20.09.2016).

27. Первый прототип самоуправляемого трактора представлен в Казани // Новости интернет вещей. URL: https://iot.ru/selskoe-khozyaystvo/p rototip-pervogo-samoupravlyaemogo-traktora-predstavlen-v-kazani (дата обращения: 20.09.2016).

28. **Ананьев А.Н.** Проблемы применения роботов в сельскохозяйственном производстве. URL: http://www.biz-for.ru/robotics/robotsprobl/robotsprobl.php (дата обращения: 18.08.2016).

ALETDINOVA Anna A. — Novosibirsk State Technical University.
630073. K. Marksa av. 20. Novosibirsk. Russia. E-mail: aletdinova@corp.nstu.ru

АЛЕТДИНОВА Анна Александровна — доцент Новосибирского государственного технического университета, кандидат технических наук.
630073, пр. К. Маркса, д. 20, г. Новосибирск, Россия. E-mail: aletdinova@corp.nstu.ru

D.A. Radoushinsky

THE IMPACT OF PUBLIC-PRIVATE PARTNERSHIPS ON THE DEVELOPMENT OF COMMUNICATIVE ENVIRONMENT OF INNOVATIVE ECONOMY

Д.А. Радушинский

ВОЗДЕЙСТВИЕ ГОСУДАРСТВЕННО-ЧАСТНОГО ПАРТНЕРСТВА НА РАЗВИТИЕ КОММУНИКАТИВНОЙ СРЕДЫ ИННОВАЦИОННОЙ ЭКОНОМИКИ

The paper examines the impact of public-private partnership on the economy growth factors associated with communications and the possibility of the existing PPP centers to run functions of communication centers. The study draws a model of public-private partnership system based on the background of causing one other economic growth factors that are related to the open communicative innovation economy. The model shows the appearance of axis «Communication» − «partnership» − «innovation» − «development» on the basis of a long-term relationship of trust within the PPP between the subjects of the state and business. This relationship enhance the mutual dependence of subjects and the intensity of the exchange of information and thus become, communication − active. As part of the bunch «communication» − «partnership» the features of the mutual initiative in PPP-projects and the essential nature of PPP are described. The characteristics and objectives of PPP development in Russia are examined on the background of analysis of partnership between the state and the private sector in a number of economies in the world. The medium and long term factors are revealed, preventing the increase of the level of involvement of private funds − both from domestic and foreign investors − in relation to public spending, and in relation to GDP. The importance of the international dimension of PPP development in Russia on the basis of the available Russian experience is pointed: concession agreements with foreign investors, are historically one of the key tools to attract foreign investment. It is concluded that in the view of innovative development of Russian economy the development of PPPs strategies should include orientation on the external international partners. An approach is suggested to the study of issues of coordination of the development of PPPs with long-term priorities of innovative development of the economy through the system of communication centers. An assessment of compliance is made of the functions ran by PPP centers operating today to the set of functions and features that are related to the concept of communication centers of innovation infrastructure. The study suggests a method of calculation of the integrated economic effect from the involvement of foreign partners into the joint activity on creation of an innovative product under the PPP. It was concluded that such an effect will be one of particular indicators of the effectiveness of communication in innovation, which arises due to the international nature of cooperation within PPP.

PUBLIC-PRIVATE PARTNERSHIP; COMMUNICATION ACTIVE RELATIONSHIPS; COMMUNICATION CENTER OF THE INNOVATION INFRASTRUCTURE; INNOVATION SYSTEM; FOREIGN INVESTMENT.

Рассматривается влияние государственно-частного партнерства на факторы экономического роста, связанные с коммуникациями, и возможности выполнения существующими центрами ГЧП функций коммуникационных центров. На основе последовательности взаимодействия обусловливающих друг друга факторов экономического роста построена модель развития системы государственно-частного партнерства в открытой коммуникативной экономике. Модель показывает возникновение оси «коммуникации − партнерство − инновации − развитие» на основе долгосрочных доверительных отношений в рамках ГЧП между субъектами государства и бизнеса, которые повышают взаимную зависимость, интенсивность обмена информацией и становятся, таким образом, коммуникационно-активными. В рамках оси «коммуникации − партнерство» рассмотрены особенности, связанные с обоюдной инициативой в проектах и черты сущностной стороны ГЧП. Проанализированы характеристики и задачи развития ГЧП в России на фоне особенностей партнерства государства и частного сектора в ряде мировых экономик. Выявлены факторы среднесрочного и долгосрочного характера, препятствующие повышению уровня привлечения средств отечественных и иностранных инвесторов − по отношению к государственным тратам и к ВВП. Отмечена важность международного аспекта развития ГЧП в России: исходя из имеющегося российского опыта, концессионные соглашения с участием иностранных инвесторов

являются одним из ключевых инструментов привлечения зарубежных инвестиций. Сделан вывод, что в целях инновационного развития ориентацию на развитие ГЧП с включением внешних партнеров целесообразно сохранять. Предложен подход к исследованию вопросов координации развития ГЧП с долгосрочным приоритетом инновационного развития экономики через систему коммуникационных центров. Произведена оценка соответствия функций действующих сегодня центров ГЧП тому набору функций и характеристик, которые отнесены к концепции коммуникационных центров инновационной инфраструктуры. Предложен способ расчета интегрального экономического эффекта от вовлечения иностранных партнеров в совместную деятельность по созданию инновационного продукта в рамках ГЧП. Сделан вывод, что подобный эффект представляет собой один из частных показателей эффективности коммуникаций в инновационной деятельности, обусловленный международным аспектом сотрудничества в рамках государственно-частного партнерства.

ГОСУДАРСТВЕННО-ЧАСТНОЕ ПАРТНЕРСТВО; ПУБЛИЧНО-ЧАСТНОЕ ПАРТНЕРСТВО; КОММУНИКАЦИОННО-АКТИВНЫЕ ОТНОШЕНИЯ; КОММУНИКАЦИОННЫЙ ЦЕНТР ИННОВАЦИОННОЙ ИНФРАСТРУКТУРЫ; ИННОВАЦИОННАЯ СИСТЕМА; ИНОСТРАННЫЕ ИНВЕСТИЦИИ.

Introduction. At present, in the global and domestic economy, the trend to tighten relations between the state and private business in order to work together in solving economic problems has been intensified. The government and private companies, banks, international financial institutions and other entities interact widely, jointly solving new tasks.

In the modern sense *a public-private partnership* is the institutional and organizational alliance of state (or municipal authority) and business which accommodates tangible and intangible resources of both parties on a mutually beneficial contractual basis for the implementation of socially important projects and programs in a wide range of areas: from basic industries and R & D to delivery of public services [1].

The problems solved by state are related as to current public service and as to long-term development of the economy through the availability of infrastructure and support for innovation. Notably, the most funds spent through PPP in all countries where it is applied, is spent for public facilities (transport, utilities, social infrastructure, cultural facilities, historical and architectural monuments, and so on) and for public services — repair, reconstruction and maintenance of public facilities, cleaning of territories, public utilities, education, health and sports. PPP today is also widely used to finance applied innovation projects and innovation infrastructure. However, in some areas of the state responsibility — defense, law enforcement, basic science, legislation and some other areas PPP is almost never used. In the sphere of the development of natural resources, PPP is implemented in the form of concessions and PSAs, which are most common in developing countries.

PPP is studied in detail from different perspectives by foreign Russian scientists such as the Varnavskiy V.G., Vilisov M.V., Glukhov V.V., Deryabin M.V., Delmon J., Yescombe E.R., Petrov A.N., Sazonov V.E., Iastrebov O.A., and many others (for example [2−9]). In 2015 a law on PPP was legislated in Russia. It is worth noting some general studies published in recent years [9−11]. The paper of Y. Yemelyanov [9] is devoted to various aspects of the impact of the investment activities of the PPP on innovative development, including the development and adaptation of new growth points in a particularly promising technology. Also this study discloses an innovative effect, resulting from the implementation of some successful PPP projects in a number of countries and regions of the world, including the CIS countries. The paper of A.K. Kazantsev and D.A. Rubvalter [3], reprint of their 2009 study, is devoted to a comprehensive study of the mechanisms and forms of PPP, used for financing innovative activities. It analyses the possibility of transferring a number of successful international practices (from USA and other OECD countries) to Russia, also it presents a number of new project initiatives, elaborated especially for the advanced procurement of PPP in the Russian context. The paper edited by G.A. Machovickova and N.F. Efimova [10] contains a generalized theoretical information on PPPs, and analysis of completed and ongoing examples of implementation of PPP projects in the world and in Russia. The paper Ed. by E.R. Yescombe [11], inter alia, considers aspects of PPPs development in different countries, PPP disadvantages; this paper describes investment decisions and public tenders procedures under PPP, details the practical aspects of the financing

of private companies entering into PPP agreements and more.

However, nor in the known works of Russian writers, nor in the works of foreign authors the questions of the relations between the communicative nature of the innovation economy (knowledge economy) and the content of public-private partnerships are not staged, the corresponding dependencies has not been studied in applied works.

Statement of research objectives. The objectives of this study is to analyze the mechanisms of intensifying information communications in the knowledge economy with the help of PPP and to evaluate the state of competence of PPP development centers at different levels, which operate today, in comparison with the conceptual functions of communication centers of innovation infrastructure, (the elements of the development of innovative, communicative economy).

The methodology of the study. The study is based on the assumption of the special role played by the spread of public-private partnership for the development of innovation systems at regional and national level. Particular attention is paid to the potential of attracting foreign investment, which forms the international aspect of the formation of the PPP relations in Russia, having both historical and important perspective meaning.

The research unit of this article uses the idea of today's dynamic type of economic system, which connects with the concepts of «knowledge economy», «communication», «information», «innovative» economy and also includes analysis of the inducements of the parties and the institutional PPP values. A score-rating approach and the method of expert evaluations were applied.

The role played by the PPP in modern communicative economy. PPP projects most widely spread over the world in the last 20−25 years, due to the possibility to take advantage of different forms of ownership. Through PPP government has the opportunity to fulfill social functions by implementing the public interest, and private companies receive the sources of growth of profit, reputation, and market value.

The basis for cooperation of PPP participants is the coherence of their objectives. Each party of PPP, according to their characteristics and objectives, make certain contributions to joint projects. From the business is expected to provide financial resources, professional expertise, innovative technologies, efficient management. The state ensures the reliability of the projects through the provision of guarantees, tax and other benefits and by its own financial resources in a certain amount [12, p. 103]. A lot of investment PPP projects in Russia stopped without substantial government participation. Thus, the state guarantees at the federal level, or taking into the parties the federal budget (Investment Fund) − in PPP projects has been an important condition of implementation of such projects in Russia in the 2000s, which as a deterrent has been mentioned in the field study at 2010 [13].

PPPs have a long-term relationships, higher interdependence of the partners, joint risk-taking on the contrary to the other established form of government and business relations, public ordering (purchase of goods, services outsourcing from a private business entities). A typical effect of a PPP is that the state shifts focus to its activities from the specific problems of construction and operation to the administrative and control functions. Delegating through PPP executive functions to businesses, government agencies focus on control functions, regulation, compliance with the public interest. Operating risks are redistributed towards business parties, while the government continues to carry strategic risks.

Successful examples of PPP in the innovation sector of the economy (mostly abroad [14]) also indicate that the partnership with the private sector allows the state not only to solve the problems in the traditional areas, but also on the actual new directions.

The effect and the condition of mutual credit and confidence accompanying the delegation's of state functions to business leads to the situation where the state is no longer «above» the market players (the position in relations of «planning system» − «market system», in which the latter has subordinate status [15]). In the new situation state and business come relatively equal, business-partners-like relationships. Long-term relationship of trust within the PPP between the state and business entities increase the mutual dependence and the intensity of the exchange of information and thus become, communication − active.
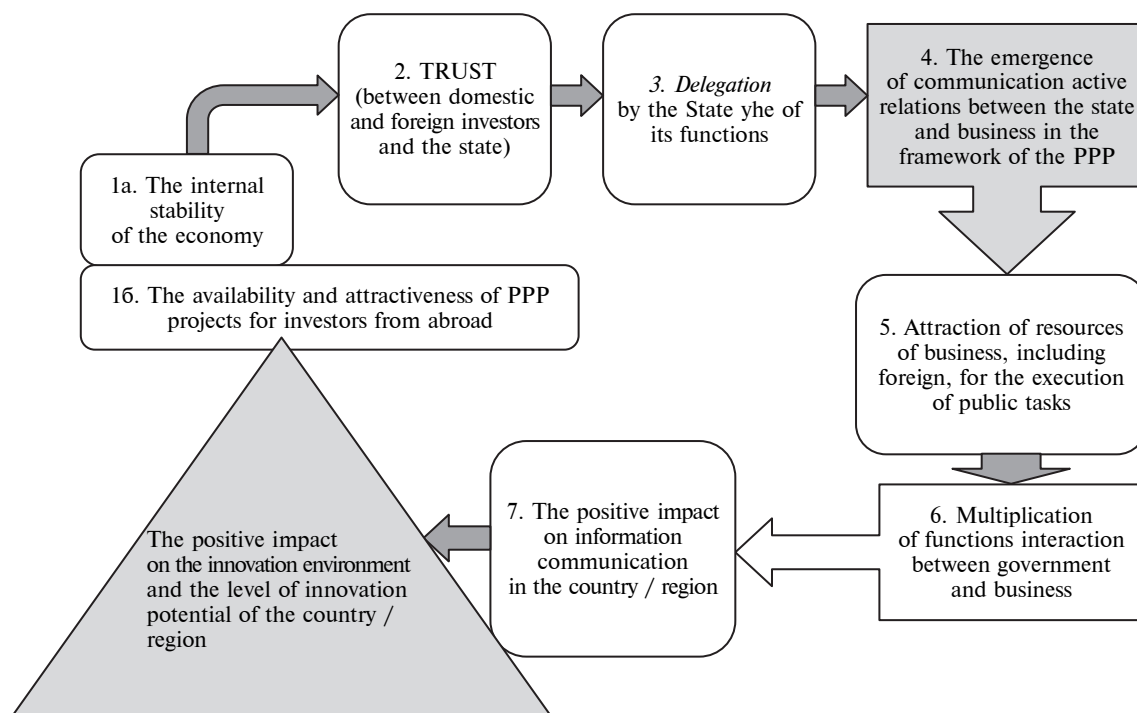
Fig. 1. Model of the impact of PPPs on the relationship of growth factors in an open communicative economy

In turn, we recall that one of the definitions of the modern dynamic type of socio-economic system, aimed at innovative development, through the creation, dissemination and use of knowledge is «communicative (or communication) economy.» The source of «innovation goods» and the primary means of accelerating and improving the quality of economic growth in such a dynamic system is a modern information communications. As noted in a number of the classic definitions of the innovation (information) socio-economic system («knowledge economy»), it is the intensity of the exchange of information / communications, allowing to convert («materialize») the knowledge into innovation products [16−21].

There can be built the following model of relations in a communicative economy on the basis of PPP (see. Fig. 1).

The action of the model is as follows. The developed system of public-private partnership demonstrates the presence of a number of premises and causing one other growth factors that are related to communication in information economies. Macroeconomic stability, on the one hand, and the availability and attractiveness of PPP projects for investors from abroad, promote the establishment of

relations of trust[1] to the state. When the state begins to delegate some of it functions under the PPP deals, this strengthens the active communication and relations within the long-term joint projects. Attracting new resources on both sides allows to expand the interaction that stimulates further information communications and increases the innovative potential of the territory. In turn, the innovation potential attracts the foreign investors and becomes the most important factor in the further sustainable development of a country or a region. The axis arises «communication» − «partnership» − «innovation» − «development».

As part of the bunch «communication» − «partnership» should be listed at least two features:

I) *Mutual initiative.* Information interaction and relatively high degree of freedom of subjects are the key features of the communication economy. They make natural the process of initiation by the both sides, state and business («Market») of joint projects. In this connection, in the current

---

[1] It should be noted that the decisive role of the phenomenon of trust in the successful interaction of the subjects of marketing systems has been repeatedly pointed by scientists marketers (P. Doyle, F. Kotler, J. Krevens, G.L. Bagiev et al., Ibid., for example [22]).

legislation on PPP, for example, provides a mechanism for private initiative (unsolicited proposals), which regulates the procedure for work with the initiatives of private investors.

2) *The form and nature of the PPP.* It should be borne in mind that communication active relations and partnership of government and business in the advanced innovation economies take a form as of PPP, as well as long-term public order (administrative contracts), and effective government institutions involved in the provision of public services as well.

The essence of «partnership» is manifested in the fact that there is business and government cooperation in the realization of common objectives relating to the provision of public services through the mechanisms of acquisition of the business income in the form of taxes and the subsequent spending of these funds either through PPP, or through a government order, or to the maintenance of government structures involved in the provision of public services. If businesses and individuals pay more taxes, that government agencies tend to provide public services on their own. In countries where the level of taxation of business and individual taxes are less, the state has fewer structures for the provision of public services and more actively «purchases» these services from the private sector (see also below).

Characteristics and objectives of PPP development in Russia on background characteristics of partnership between the state and the private sector in a number of economies in the world. The form of the PPP (PPP — public private partnership) is used more or less widely in specific countries, which identify today with innovative economy [23—25], depending on the prevailing historical patterns of interaction between business and the state in the territory and tax legislation. The vast use of PPP contracts is adherent to Anglo-Saxon legal system where the partnerships including in small and medium-sized projects is called PPP. At the same time, for example, in the French legal system, the concession contract (including in areas such as education, science, medicine), is legally referred to as administrative contract (government ordering), while the form of PPP affects only the large-scale infrastructure projects.

Spread of PPP form is related to public opinion, the tax level and the prevailing perceptions of the population of the state's role in the provision of services [26]. In European countries, where the highest percentage of GDP is redistributed through the state budget (Finland — 58 %, France — 57, Austria — 53, Sweden — 50 %) [27], the population expects the state in exchange for the high level of taxes collected will itself provide most of the services related to transportation, education, health care of the population, etc. PPP projects in these countries face with a serious opposition of the population, and the free provision of services by public bodies dominates.

In the countries of the Anglo-Saxon legal system, where historically high priorities have personal initiative of citizens and competition, the level of income tax and profit tax of are lower (UK, Ireland, USA, Australia), and more significant part of the public services is provided by private business under state supervision . Thus, the state in a number of countries (primarily the United Kingdom, the United States) is ready to transfer to the private sector through PPP the largest volume of public functions that became known as semi-privatization [28].

PPP development in Russia has its own characteristics. The share of GDP redistributed through the budget (in 2015 about 38 % [29]), in Russia is more closer to the United States (36.5 %) and the UK (40 %) than to Continental Europe countries (Germany — 43 % [30], France — 57 %) and Scandinavia (Sweden — 50 %, Finland — 58 %), however, in Russia — as in France or Scandinavia — most of the public services are provided by public agencies or on the basis of the state ordering. The spread of PPPs still has a relatively small scale.

Ongoing projects in Russia differ in their structure from the most developed countries, where the basis of PPP agreements is constituted by infrastructure projects, while the volume of PPP expands in innovative industries. The PPP agreements are not conducted in innovation areas in Russia, the most significant private investments in PPP has been made in the mining industry, where since the 1990s acts number of major PSAs (production sharing agreements). The PPP in infrastructure projects is developing (for 2015 in Russia at various stages of implementation the number of PPP projects is about 1300: 15 — at the federal level, 191 — regional, 1100 — Municipal), [31, p. 6] but still has a relatively small scale compared with several other countries.
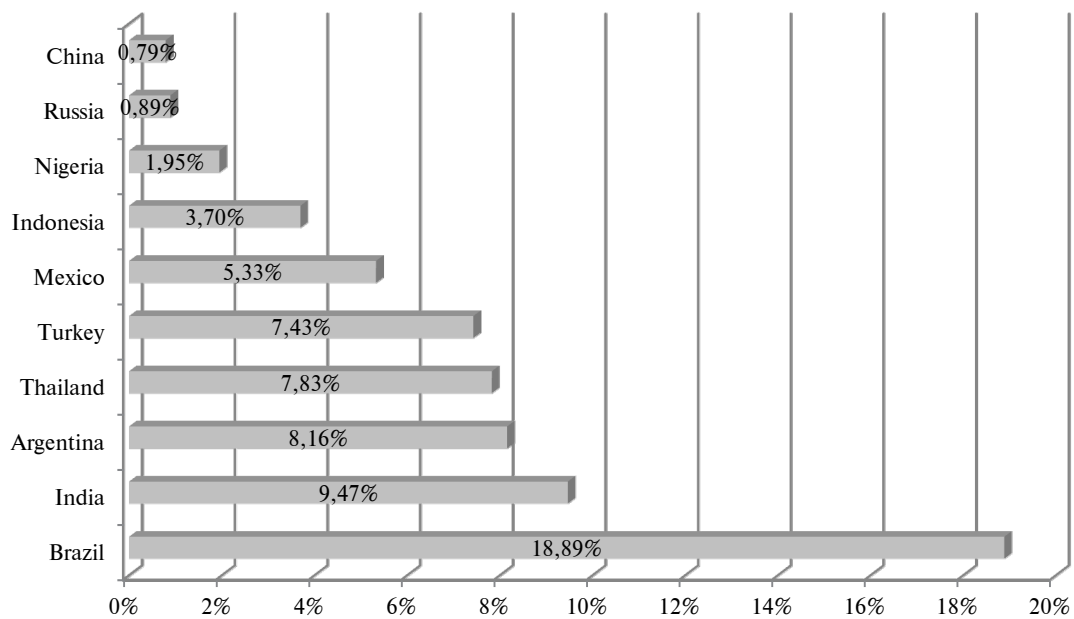
Fig.2. The ratio of private investment in PPP projects to nominal GDP. Source: [30, p. 9] − according to the World Bank, the IMF, Rosstat, calculations of PPP Development Centre.

Let's take a look at private investment in PPP projects to nominal GDP, which for Russia in 2015 is less than 1 %. Not only in the most developed economies, but today and in many countries with similar patterns and levels of investment in infrastructure in the PPP principles percentage ratio of the volume of private investment to nominal GDP is much higher (see. Fig. 2).

Moreover, in Russia the average share of the state budget funds (including those from the Investment Fund of the Russian Federation), in the joint PPP projects is above average being close to 50−60 % vs. 20−35 % average in the world, [9−11]. In these circumstances, the experts deem appropriate efforts aimed at increasing the level of involvement of private funds − both domestic and foreign investors − in relation to public spending, and in relation to GDP. In Russia, the latter ratio in order to achieve a balance within the process of attracting infrastructure investments on the principles of PPP must reach a level of around 4−5 % of GDP, as estimated [31, p. 9] (4−5 times greater than the current level, see. Fig. 2).

On the way to perform this task there is a number of obstacles having a medium-term (pertaining to the financial crisis and the sanctions regime) as well as long-term, institutional character. In the medium term an indefinite period of the financial «sanctions», the difficulties experienced domestic financial market, and the possible defaults could undermine as indicated [31, p. 6], the credibility of the regional and municipal authorities to concessionaires. In the long term, the most significant are the institutional problem of trust on the part of private partners − apprehension of high costs of corruption and limitations on the participation of foreign capital.

The task of raising the level of involvement of private funds − both domestic and foreign investors − in relation to public spending, and in relation to GDP by PPP is a matter of qualitative improvement of relations. This formal quantitative increase in the number of PPP agreements in Russia, as in the traditional areas of application as well as in the sphere of innovation risks only become a new form of acting system of distribution of state funding and state property management [32]. In the case of quantitative increase, there may be an increase in the share of budgetary funds accumulated in PPP contracts, but the volume of attracted private funds did not significantly increase, as there will no trust relations established, the qualitative factors wouldn't enhance communication intensity.

Coordination of PPP with long-term priorities of innovative development of the economy through the system of the communication centers. Innovative development is based both on the own achievements, and the successful development of exchange and borrowing of advanced innovative technologies and organizational experience. It is believed that the involvement of technology and expertise is most likely a result of foreign direct investment, and PPP has forms that provide opportunities for direct investment. However, even if only portfolio and financial investments of institutional investors, known infrastructure companies from abroad are carried out within the PPP, the level of innovation in the regions where these international projects are implemented, indirectly will increase [33].

Historically, much of PPP development in Russia was due to the involvement of foreign private capital. Concessions with the involvement of foreign companies have been widely used in Tsar Russia, during the NEP, the period of industrialization in the Soviet Union. Concession agreements and production sharing agreements (PSAs) with foreign companies were concluded in the 1990s. However, assessing the effectiveness of the latter are rather contradictory[2].

In general, based on the available Russian experience, concession agreements with foreign investors, it is one of the key tools to attract foreign investment [34]. In this regard, it is worth to note that in contrast to the Law on Concessions, 2005 [35] in the Law on PPPs adopted in 2015 [35] only the Russian legal entity may act as a private partner. The Law on PPPs so today is focused on partners − residents, while the Law on Concessions is open to the foreign investors.

To date, the involvement of foreign investors is complicated by the financial crisis and political contradictions. Loss of access to direct and portfolio investment from Western countries − the traditional partners (Germany, the EU as a whole) come to a need to find them on the markets of China and other emerging economies of Asia, which have the surpluses in trade balance of payments. [37] Experience of 2014−2016 showed that the attraction of direct and portfolio investments and credits from China and the leading countries − exporters of oil (especially the so-called «Gulf monarchies») remains today a difficult task for Russian companies and state.

Despite these complexities, focus on the development of PPPs should include external partners in order to keep the innovative development expedient. Within the framework of the provisions of the presented model (Fig. 1) on the attractiveness of the economy to foreign investors affects *communication active* nature of PPP, providing a positive impact on the innovation environment and innovation potential of the country / region, and then causing the internal stability of the economy. Coordination of PPP development process with the long-term priorities of innovation development of economy it is advisable to carry out on the basis of the communication aspects of PPPs.

In Russia PPP centers today are working on a number of levels. The PPP-centers in cross − sectoral Ministries of Regional Development, Economic Development and Finance cooperate with Vnesheconombank and the Investment Fund of the Russian Federation on strategic planning and management of the implementation of PPP projects of national and regional scales, which are based on the investment and construction projects, mainly in the form of a concession. At the regional and municipal level are local centers − for example, public-private partnership projects department of the Committee for Investments and Strategic Projects of St. Petersburg Government.

Existing regional, cross − sectoral and departmental PPP development centers, performing the tasks of activation of private investments in joint projects with the government, are important actors of the existing innovation infrastructure.

From the point of view of the author, the current PPP centers can be considered as a regional and interregional-and-coordinating communication centers of innovation infrastructure. In accordance with the author's concept [38], the primary function of communication center in the socio-economic system with a given level of development is the organization of interaction with the representatives of socio-economic systems with the same or higher level of development in order to obtain from them

---

[2] Conditions and results of executing the largest number of PSAs in Russia regularly received negative assessments of the Audit Chamber.

(through the exchange, purchase, etc.) advanced technology, skills and other kinds of valuable information and knowledge.

Communication centers of innovation infrastructure for today is the scientific concept, which implementation needs to be further verified at technical and economic level. However today, the part of their intended functions are already implemented by a number of existing innovation infrastructure subjects (actors) at the federal and regional levels, including the PPP centers, scientific and industrial centers of large companies, research and innovation centers at universities.

In this study, we consider it appropriate to assess the conformity of the functions of PPP centers operating today to the set of functions and features that are related to the concept of communication centers of innovation infrastructure. This assessment has been made by a number of experts with the using of the score-rating system. The tab. 1 (see. below) shows in column 2 the basic and the additional characteristics (functions) of communication centers, in columns 4−6 shows matching scores from 0 to 5 (by expert assessment), column 3 shows the rating of the given characteristic in percentage.

Table 1

Conformity assessment of conceptual characteristics (functions) of the innovation infrastructure communication center to the functions of existing cross − sectoral, regional and departmental PPP centers.

№	Basic and additional characteristics (functions) of the communication center of innovation infrastructure	Rating of the characteristic, %	Cross − sectoral	Regional	Departmental	Comments
1	2	3	4	5	6	7
1	intensively involved in the process of «diffusion of innovations»	15	2	3	3	Coordinates the process of «diffusion»
2	integrates directly interacting units that are grouped geographically which is expedient for the informal transmission of «tacit knowledge»	10	0	2	2	Does not have in its structure the scientific and industrial organizations
3	it has the organizational and managerial authority	25	5	2	2	According to the current practice
4	international character due to orientation towards collaboration with foreign partners	15	3	2	1	Depending on the ability to influence on foreign partners
5	focus on actual mechanisms and legal forms of public-private partnership (PPP)	10	5	3	4	Depending on the proximity to the developers of legislative norms
6	a significant PR-component that can engage the «creative class» within the country and foreign business partners in the communication center activities	15	1	2	0	The function corresponds to specific identi-fiable projects in the regions
7	providing humanitarian and business cooperation with the state and Russian military structures, including the structures the Rear the Russian Armed Forces	10	0	1	0	
	Total grade	**100 %**	**2,65**	**2,15**	**1,70**	

Thus, the most competent in carrying out the functions of communication centers of innovation infrastructure today can be regarded the cross-sectoral PPP centers in the Ministry of Regional Development, Economic Development, Finance (total grade 2.65 out of 5 points). This assessment of their level of compliance enables them to perform the conditional tasks of *coordinating communication centers* at the interregional and cross-sectoral level.

Existing regional PPP centers can now carry out more than 40 % of the conceptual functions of communication centers of innovation infrastructure (total grade 2.15 of 5). This assessment should be recognized as inadequate to carry the competence of communication centers of innovative infrastructure in the regions (Federal districts). This level should be the most high (at least 90 %) in order to be able to support local projects at the appropriate level. The full development of the communication component for regional PPP centers implies the need to develop the remaining set of functions (functions of performance competencies) within the newly established structural units within regional centers PPP or through specially created new structures.

As to regard to the departmental centers, for them it would be optimal to have a total grade of about 2.5 out of 5, which would allow them to play a *coordinating communication* role within their industries at a sufficient level. However, the current total grade (1.7 of 5), means the feasibility of reinforcing of competencies in a number of functions they perform, such as «collaboration with foreign partners», «PR-component».

Such issues as the further evaluation of the current levels of competence of the existing subjects of innovation infrastructure, including PPP development centers, as well as justification of sufficient and target levels of the implementation by the existing subjects of innovation infrastructure of conceptual functions of communication centers are subject to further methodological and practical analysis.

The approach to the calculation of the integral economic effect from the involvement of foreign partners in joint ventures to create an innovative product under the PPP. One of the basic characteristics of the communication centers is its focus on international cooperation.

To assess the PPP instruments opportunities in attracting foreign partners for joint innovation it is appropriate to measure the economic effect of the integral involvement of foreign partners in joint ventures to create an innovative product under the PPPs. Such an effect will be one of particular indicators of the effectiveness of communication in innovation, which arises due to the international aspect of cooperation within the PPPs.

It should be understood that the measurement of this effect in the current conditions, while the experience of involving foreign partners in PPPs in Russia has a single nature, will be quite evaluative. This measurement is based on an attempt to quantify the number of quality indicators, including reputational effect, reflecting the attraction for cooperation (may be known) international company compared with the implementation of a project to create an innovative product under the PPP involving domestic partner.

In addition, for such comparisons one must have a valid data on the financial results of the project in different conditions. Once such data is obtained, then for calculation of the integral economic effect of the involvement of a foreign partner in a joint activity on creation of an innovative product under PPP, you can use the following basic formula:

$$E_{ief} = FR_f \, k_1 \, k_2 \, k_3 - FR_d,, \qquad (1)$$

where FR_f (NPV_f) − the expected financial results of the project to create an innovative product under the PPP with the involvement of international company; k_1 − coefficient of determining the scope of the project in the range [0,5:2]: 0.5 − municipal project, the total cost of the project up to 100 mln. rub.; 1 − regional project, cost from 100 to 500 mln. rub.; 1.5 − regional or interregional project, cost from 500 million to 5 billion rubles.; 2 − a federal project cost more than 5 billion rubles; k_2 − coefficient that determines the level of business reputation (recognition) of a foreign (international) company attracted to cooperate in a project to create an innovative product under the PPP in the range [1: 2]: 1 − the company is known (is recognized) in its country; 2 − the company is a world leader, cooperation with which brings the highest reputational effect; k_3 − coefficient of the

share of private capital in the project to create an innovative product under the PPP involving international company compared with domestic partner (as determined by the division of relevant shares); FR_d (NPV_d) — the expected financial results of the project to create an innovative product under the PPP with the involvement of domestic company;

Calculation example. We assume that data is available: FR_f — 55 mln. rub.; project cost 1 bn. rub.; attracting foreign company which successfully operates in several countries, k_2 can be assessed at a rate of 1.5; the share of private capital in the project with the involvement of the international company — 55 %; the share of private capital in the project with the involvement of domestic company — 65 %; FR_d — 76 mln. rub.

In this case, the *integral economic effect*

$$E_{ief} = 55 \cdot 1.5 \cdot 1.5 \cdot 55\ \% \ /\ 65\ \% - 76 =$$

$$= 28.71 \text{ mln. rub.}$$

One should note that the calculation of the financial results of the implementation of innovative projects (FR_f, FR_d) is of high uncertainty, only with the serious adjustments it is possible to use the individual data from the similar projects, if such data are applicable. To justify the statistical significance of relationships, which may be obtained for projects to develop innovative products under the PPPs with the involvement of the international company, one must have the data sets that reflect such experience. At present, such data is only partially available from the international practice of foreign companies in innovation projects under the PPP.

In addition, we should note that there is a possibility of supplementing the basic formula presented above with extra coefficients which would reflect the number of features an innovative project, which hasn't been taken into account, in particular: a) the industry of the project (does it belongs to a priority set of industries for innovative development in the country); b) the number of additional jobs created; c) the property rights on the results of an innovative project; g) the possibility of using the results of realization of the innovative project in the other projects and industries within the country and abroad, and others.

In this case, it is expedient to introduce an additional coefficient which takes into account a number of factors mentioned above on the balanced strength of their influence — k_{add}. As an alternative, it can be considered an integral coefficient taking into account the weighted influence on integral economic effect of the involvement of a foreign partner in a joint activity on creation of an innovative product in the PPP of all factors, including those that were represented by the coefficients k_1—k_3.

In this case, the formula (1) takes the form:

$$E_{ief} = FR_f\, k_{int} - FR_d\,, \qquad (2)$$

where k_{int} — integral coefficient taking into account the weighted impact on integral economic effect of the involvement of a foreign partner in a joint activity on creation of an innovative product in the PPP extended set of factors.

$$k_{int} = \sum_{i=1}^{n} a_i\, b_i\,, \qquad (3)$$

where a_i — weight of i characteristics (influence factor); b_i — value of i characteristics (influence factor).

Here is an example calculation of the integral factor. Let Krylov marine constructing bureau (Saint-Petersburg) as the coordinator of the PPP project is considering engaging in a joint project for the development of documentation and the creation of a prototype of high-tech equipment for the production of hydrocarbons on the Arctic shelf [39] three potential partners — from Russia (JSC «Central Research Institute of the Navy», JSC «Far Eastern center of shipbuilding and Ship Repair» (FECSR)), from China and the group of companies from Norway — Finland. Expert assessment of the impact of force, the importance (significance) of various factors (characteristics) in the project PPP potential partners on the integral gain and a comparison of the values of obtained integral coefficients are given in Tab. 2.

The calculation results in Tab. 2 show that for the partner from China produced results: $k_{int} = 1,00375$, to partner group from Norway — Finland $k_{int} = 1,05625$. Next, to calculate the effect of the integral values of obtained k_{int} should be substituted into the formula (2).

Expert evaluation of the significance of the characteristics of participation in the PPP project ofP various partners and integral economic effect of the involvement of a foreign partner in a joint activity on creation of an innovative product under PPP

№	Features (factors) of innovative PPP projects that have an impact on integral economic effect	Rating of the characteristic, %	Partner from Russia	Partner from China	Partner from Norway Finland
1	2	3	4	5	6
1	level of business reputation (recognition) of a foreign or domestic company attracted to cooperate in a project	20	1	0,75	1,1
2	the share of private capital in the project	15	1 (60 %)	1,125 (65 %)	0,875 (55 %)
3	the number of additional jobs created	12,5	1	1,2	1,3
4	the property rights on the results of an innovative project;	12,5	1	0,9	0,8
5	the possibility of using the results of realization of the innovative project in the other projects and industries within the country	12,5	1	0,85	0,8
6	the possibility of using the results of realization of the innovative project in the other projects and industries abroad	12,5	1	1,15	1,3
7	Communication effects of the involvement of specialists − a partner in a joint operation	15	1	1,15	1,2
	Total evaluation − integral coefficient k_{int}	**100 %**	1	1,00375	1,05625

The results of the study. The following results were obtained within this work.

1. A model of public-private partnership system is drawn based on the background of causing one other economic growth factors that are related to the open communicative innovation economy. The model shows the appearance of axis «Communication» − «partnership» − «innovation» − «development» on the basis of a long-term relationship of trust within the PPP between the subjects of the state and business. This relationship enhance the mutual dependence of subjects and the intensity of the exchange of information and thus become, communication − active. As part of the bunch «communication» − «partnership» the features of the mutual initiative in PPP-projects and the essential nature of PPP are described.

2. Based on the analysis of the features of partnership of the state and the private sector in a number of economies in the world it is revealed that the task of raising the level of involvement of private funds through PPP − of domestic and foreign investors − depends on quality installation to enhance the intensity of communication and inclusion of foreign partners in the innovative development programs.

3. As part of the quantitative determination of PPP impact on the communication environment of innovation economy an assessment of compliance is made of the functions ran by PPP centers operating today to the set of functions and features that are related to the concept of communication centers of innovation infrastructure.

4. The study suggests a method of calculation of the integrated economic effect from the involvement of foreign partners into the joint activity on creation of an innovative product under the PPP. It was concluded that such an effect will be one of particular indicators of the effectiveness of communication in innovation, which arises due to the international nature of cooperation within PPP.

As the direction of future research the author sees the deepening of analysis of functions and competencies of existing innovation infrastructure subjects at the federal and regional levels, including the PPP centers, research and production centers of large companies, scientific-innovative centers at universities. Also there would be a need for a rationale for investment in the creation of additional structural units of existing innovation infrastructure subjects, or creating a special communication centers.

REFERENCES

1. Varnavskii V.G. Partnerstvo gosudarstva i chastnogo sektora: formy, proekty, riski. M.: Nauka, 2010. (rus)

2. Gosudarstvenno-chastnoe partnerstvo v innovatsionnoi sfere: mirovoi opyt i perspektivy Rossii. Pod red. R.M. Nizhegorodtseva, S.M. Nikitenko, E.V. Goosen. Kemerovo: Sibirskaia izdatel'skaia gruppa, 2012. 482 s. (rus)

3. **Kazantsev A.K.,** Rubval'ter D.A. Gosudarstvenno-chastnoe partnerstvo v nauchno-innovatsionnoi sfere. M: Infra-M, 2015. 330 s. (rus)

4. **Kireeva A.V., Khud'ko E.V., Sokolov I.A., Tishchenko T.V.** Gosudarstvenno-chastnoe partnerstvo kak instrument podderzhki innovatsii. Pod red. I.A. Sokolova. M.: Izd. dom «Delo» RANKhiGS, 2012. 514 s. (rus)

5. **Delmon J.** Understanding Options for Public-Private Partnerships in Infrastructure. Sorting Out the Forest from the Trees. World Bank, Washington DC, Policy Research Working Paper 5173, January 2010.

6. **Delmon J.** Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risk. The World Bank and Kluwer Law International, 2009. 600 r.

7. Public Private Partnership: Ein Leitfaden fur offentliche Verwaltunguud Unternehmer (Dokumentation). *Bundesministerium fur Wirtschaft und Arbeit.* 2009.

8. **Mochal'nikov V.** Gosudarstvenno-chastnoe partnerstvo. Otechestvennyi opyt, mirovye tendentsii, vektor razvitiia dlia Rossii. M.: Ekonomika, 2012. 352 s. (rus)

9. **Emel'ianov Iu.S.** Gosudarstvenno-chastnoe partnerstvo. Innovatsii i investitsii. Mirovoi i otechestvennyi opyt. M.: Librokom, 2013. 368 s. (rus)

10. **Makhovikova G.A., Efimova N.F.** Gosudarstvenno-chastnoe partnerstvo: zarubezhnyi opyt i rossiiskie realii. SPb.: Izd-vo SPbGEU, 2013. 251 s. (rus)

11. **Ieskomb E.** Gosudarstvenno-chastnoe partnerstvo: Osnovnye printsipy finansirovaniia. M.: Al'pina pablisher, 2015. 457 s. (rus)

12. **Babkin I.A., Zherebov E.D. The** mechanism of interaction between government and business on the basis of state-private partnership. *St. Petersburg State Polytechnical University Journal. Economics*, 2015, no. 4(223), pp. 99−107. DOI: 10.5862/JE.223.9 (rus)

13. Razvitie gosudarstvenno-chastnogo partnerstva v regionakh TsFO: investitsii i infrastruktura. − otchet po rezul'tatam issledovaniia Tsentra GChP i Instituta sovremennogo razvitiia. M., 2010. URL: http://pppcenter.ru/assets/files/Anons/a_CFO%203.pdf (data obrashcheniia: 21.07.2016).

14. **Radushinskii D.A.** Osobennosti realizatsii soglashenii o gosudarstvenno-chastnom partnerstve v innovatsionnoi sfere. Peterburgskii ekonomicheskii zhurnal. 2016. № 2. S. 70−78. (rus)

15. **Gelbreit Dzh.K.** Novoe industrial'noe obshchestvo. Izbrannoe. M.: Eksmo, 2008, 1200 s. (rus)

16. The Knowledge-based Economy. Paris, OECD, 1996.

17. **Lopez-Martinez E., Piccaluga A.** Knowledge Flows in National Systems of Innovation. Cheltenham, Edward Elgar, 2000.

18. New economy: innovation insight into Russia / Center of Strategic Partnership. Moscow, Liga-Print. 2008. 223 p.

19. **Lundvall B.** National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning. New York, Anthem Press, 2010.

20. **Lee K.** Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-creation, and the Middle-income Trap. Cambridge, Cambridge University Press, 2013.

21. Institut Vsemirnogo banka. K4D. Znaniia dlia razvitiia. Izmerenie znanii v ekonomikakh mira. URL: http://siteresources.worldbank.org/INTUNIKAM/Resources/KAM_v4.2015.pdf (data obrashcheniia: 05.10.2016) (rus); **Chen Derek H.C., Dahlman Carl J.** The knowledge economy, the KAM methodology and World Bank operations. Washington, DC: World Bank, 2006. http://documents.worldbank.org/curated/en/695211468153873436/ The-knowledge-economy-the-KAM-methodology-and-World-Bank-operations. 42 p. (accused October 05, 2016).

22. **Naumov V.N., Sharapova O.A.** Formirovanie vospriiatiia sobstvennoi torgovoi marki roznichnogo predpriiatiia. *Brend-Menedzhment.* 2009. № 1. S. 28−35. (rus)

23. Global'nyi indeks konkurentosposobnosti «Global Competitiveness Index» (GCI) Vsemirnogo ekonomicheskogo foruma. URL: http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/ (data obrashcheniia: 29.07.2016). (rus)

24. Global'nyi innovatsionnyi indeks «Global innovation index» (GII). URL: https://www.globalin novationindex.org/gii-2015-report (accussed July 29, 2016).

25. Reiting Doing Business — issledovanie, provodimoe Vsemirnym bankom i Mezhdunarodnoi finansovoi korporatsiei. URL: http://www.doingbusin ess.org/rankings (data obrashcheniia: 29.07.2016). (rus)

26. **Airapetian M.S.** Zarubezhnyi opyt ispol'zovaniia gosudarstvenno-chastnogo partnerstva. URL: http://iam.duma.gov.ru/node/8/4669/16628 (data publikatsii: 12.2008). (rus)

27. **Repko M., Piontkovskaia I., Kukhta P.** Kakoi dolzhna byt' dolia gosudarstva v ekonomike? — URL: http://economics.lb.ua/state/2015/12/08/322795_kako y_dolzhna_dolya_gosudarstva.html (data publikatsii: 08.12.2015). (rus)

28. **Koroleva A.I., Babkin I.A.** Elements of public_private partnership as a mechanism innovation economy. *St. Petersburg State Polytechnical University Journal. Economics*, 2013, no. 1—1(163), pp. 31—38. (rus)

29. **Tishchenko T.** Gosudarstvennyi biudzhet. URL: http://www.iep.ru/files/RePEc/gai/ruserr/515Tis hchenko.pdf (data obrashcheniia: 10.08.2016). (rus)

30. **Larina S.E.** Obshchee i osobennoe v razvitii biudzhetnoi detsentralizatsii. *Vestnik AGU.* 2013. № 4(131). URL: http://vestnik.adygnet.ru/files/ 2013.4 /3082/46-55.pdf (data obrashcheniia: 10.08.2016). (rus)

31. Reiting regionov Rossii po urovniu razvitiia gosudarstvenno-chastnogo partnerstva 2014—2015. M.: Tsentr razvitiia GChP, 2016. URL: http://pppi.ru/sites /default/files/docs/rating2016.pdf (data obrashcheniia: 08.08.2016). (rus)

32. **Gordenko G.V.** Gosudarstvenno-chastnoe partnerstvo v innovatsionnoi sfere: perspektivy razvitiia v Rossii. *Modernizatsiia Rossii: kliuchevye problemy i resheniia : mater. XIII Mezhdunar. nauch. konf.* (Moskva, 20—21 dekabria 2012 g.). M., 2013. URL: http://www.gosbook.ru/node/72995 (data obrashcheniia: 14.08.2016). (rus)

33. **Shlafman A.I.** The Genesis of the integration processes in the economy of the Russian Federation: the problem of cyclicity and state regulation. *St. Petersburg State Polytechnical University Journal. Economics*, 2013, no. 6(185), pp. 39—47. (rus)

34. Praktika primeneniia kontsessionnykh soglashenii dlia razvitiia regional'noi infrastruktury v Rossii. Ministerstvo ekonomicheskogo razvitiia Rossiiskoi Federatsii. M., 2014. URL: http://economy. gov.ru/minec/activity/sections/privgovpartnerdev/ 2014112710 (data obrashcheniia: 21.07.2016). (rus)

35. O kontsessionnykh soglasheniiakh: Federal'nyi zakon Rossiiskoi Federatsii № 115—FZ ot 21.07.2005 g. (red. 30.12.2015 g.). *SPS «Konsul'tantPlius».* (rus)

36. O gosudarstvenno-chastnom partnerstve, munitsipal'no-chastnom partnerstve v Rossiiskoi Federatsii i vnesenii izmenenii v otdel'nye zakonodatel'nye akty Rossiiskoi Federatsii (Zakon o GChP): Federal'nyi zakon Rossiiskoi Federatsii № 224-FZ ot 13.07.2015 g. (red. 03.07.2016 g.). *SPS «Konsul'tantPlius».* (rus)

37. **Afontsev S.A.** Vykhod iz krizisa v usloviiakh sanktsii: missiia nevypolnima? URL: http://institutio nes.com/general/2562-vyxod-iz-krizisa-v-usloviyax-sankcij.html (data obrashcheniia: 12.08.2016). (rus)

38. **Radoushinsky D.A., Zdolnikova S.V.** Communication centers as an element of the institutional environment of innovative economy. *St. Petersburg State Polytechnical University Journal. Economics*, 2015, no. 5(228), pp. 54—63. DOI: 10.5862/JE.228.5

39. **Borodin V.V., Vas'kov N.N., Kalistratov N.Ia.** i dr. O sozdanii i razvitii spetsializirovannoi verfi «Arktika — shel'f». *Arktika i Sever.* 2014. № 17. S. 14—21. (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Варнавский В.Г.** Партнерство государства и частного сектора: формы, проекты, риски. М.: Наука, 2010.

2. Государственно-частное партнерство в инновационной сфере: мировой опыт и перспективы России / под ред. Р.М. Нижегородцева, С.М. Никитенко, Е.В. Гоосен. Кемерово: Сибирская издательская группа, 2012. 482 с.

3. **Казанцев А.К., Рубвальтер Д.А.** Государственно-частное партнерство в научно-инновационной сфере. М: Инфра-М, 2015. 330 с.

4. **Киреева А.В., Худько Е.В., Соколов И.А., Тищенко Т.В.** Государственно-частное партнерство как инструмент поддержки инноваций / под ред. И.А. Соколова. М.: Изд. дом «Дело» РАНХиГС, 2012. 514 с.

5. **Delmon J.** Understanding Options for Public-Private Partnerships in Infrastructure. Sorting Out the Forest from the Trees. World Bank, Washington DC, Policy Research Working Paper 5173, January 2010.

6. **Delmon J.** Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risk. The World Bank and Kluwer Law International, 2009. 600 p.

7. Public Private Partnership: Ein Leitfaden fur offentliche Verwaltunguud Unternehmer (Dokumentation) // Bundesministerium fur Wirtschaft und Arbeit. 2009.

8. **Мочальников В.** Государственно-частное партнерство. Отечественный опыт, мировые тенденции, вектор развития для России. М.: Экономика, 2012. 352 с.

9. **Емельянов Ю.С.** Государственно-частное партнерство. Инновации и инвестиции. Мировой

и отечественный опыт. М.: Либроком, 2013. 368 с.

10. **Маховикова Г.А., Ефимова Н.Ф.** Государственно-частное партнерство: зарубежный опыт и российские реалии. СПб.: Изд-во СПбГЭУ, 2013. 251 с.

11. **Йескомб Э.** Государственно-частное партнерство: Основные принципы финансирования. М.: Альпина паблишер, 2015. 457 с.

12. **Бабкин И.А., Жеребов Е.Д.** Механизм взаимодействия государства и бизнеса на основе государственно-частного партнерства // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2015. № 4(223). С. 99—107. DOI: 10.5862/JE.223.9

13. Развитие государственно-частного партнерства в регионах ЦФО: инвестиции и инфраструктура. — отчет по результатам исследования Центра ГЧП и Института современного развития. М., 2010. URL: http://pppcenter.ru/assets/files/Anon s/a_CFO%203.pdf (дата обращения: 21.07.2016).

14. **Радушинский Д.А.** Особенности реализации соглашений о государственно-частном партнерстве в инновационной сфере // Петербургский экономический журнал. 2016. № 2. С. 70—78.

15. **Гелбрейт Дж.К.** Новое индустриальное общество. Избранное. М.: Эксмо, 2008, 1200 с.

16. The Knowledge-based Economy. Paris: OECD, 1996.

17. **Lopez-Martinez E., Piccaluga A.** Knowledge Flows in National Systems of Innovation. Cheltenham, Edward Elgar, 2000.

18. New economy: innovation insight into Russia / Center of Strategic Partnership. Moscow: Liga-Print. 2008. 223 p.

19. **Lundvall B.** National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning. New York: Anthem Press, 2010.

20. **Lee K.** Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-creation, and the Middle-income Trap. Cambridge: Cambridge University Press, 2013.

21. Институт Всемирного банка. K4D. Знания для развития. Измерение знаний в экономиках мира. URL: http://siteresources.worldbank.org/INT UNIKAM/ Resources/KAM_v4.2015.pdf (дата обращения: 05.10.2016); **Chen Derek H.C., Dahlman Carl J.** The knowledge economy, the KAM methodology and World Bank operations. Washington, DC: World Bank, 2006. http://documents.worldbank.org/curated/en/695211468153873436/The-knowledge-economy- the-KAM-methodology-and-World-Bank-operations, 42 p. (дата обращения: 05.10.2016).

22. **Наумов В.Н., Шарапова О.А.** Формирование восприятия собственной торговой марки розничного предприятия // Бренд-Менеджмент. 2009. № 1. С. 28—35.

23. Глобальный индекс конкурентоспособности «Global Competitiveness Index» (GCI) Всемирного экономического форума. URL: http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/ (дата обращения: 29.07.2016).

24. Глобальный инновационный индекс «Global innovation index» (GII). URL: https://www.globalinnovationindex.org/gii-2015-report (дата обращения: 29.07.2016).

25. Рейтинг Doing Business — исследование, проводимое Всемирным банком и Международной финансовой корпорацией. URL: http://www.doingbusiness.org/rankings (дата обращения: 29.07.2016).

26. **Айрапетян М.С.** Зарубежный опыт использования государственно-частного партнерства. URL: http://iam.duma.gov.ru/node/8/4669/16628 (дата публикации: 12.2008).

27. **Репко М., Пионтковская И., Кухта П.** Какой должна быть доля государства в экономике? — URL: http://economics.lb.ua/state/2015/12/08/322795_kakoy_dolzhna_dolya_gosudarstva.html (дата публикации: 08.12.2015).

28. **Королева А.И., Бабкин И.А.** Элементы государственно-частного партнерства как механизма инновационного развития экономики // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2013. № 1—1(163). С. 31—38.

29. **Тищенко Т.** Государственный бюджет. URL: http://www.iep.ru/files/RePEc/gai/ruserr/515Ti shchenko.pdf (дата обращения: 10.08.2016).

30. **Ларина С.Е.** Общее и особенное в развитии бюджетной децентрализации // Вестник АГУ. 2013. № 4(131). URL: http://vestnik.adygnet.ru/files/2013.4/3082/46-55.pdf (дата обращения: 10.08.2016).

31. Рейтинг регионов России по уровню развития государственно-частного партнерства 2014—2015. М.: Центр развития ГЧП, 2016. URL: http://pppi.ru/sites/default/files/docs/rating2016.pdf (дата обращения: 08.08.2016).

32. **Горденко Г.В.** Государственно-частное партнерство в инновационной сфере: перспективы развития в России // Модернизация России: ключевые проблемы и решения : матер. XIII Междунар. науч. конф. (Москва, 20—21 декабря 2012 г.). М., 2013. URL: http://www.gosbook.ru/node/72995 (дата обращения: 14.08.2016).

33. **Шлафман А.И.** Генезис интеграционных процессов в экономике Российской Федерации: проблемы цикличности и государственного регулирования // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2013. № 6(185). С. 39—47.

34. Практика применения концессионных соглашений для развития региональной инфра-

структуры в России / Министерство экономического развития Российской Федерации. М., 2014. URL: http://economy.gov.ru/minec/activity/sections/ privgovpartnerdev/ 2014112710 (дата обращения: 21.07.2016).

35. О концессионных соглашениях: Федеральный закон Российской Федерации № 115–ФЗ от 21.07.2005 г. (ред. 30.12.2015 г.) // СПС «КонсультантПлюс».

36. О государственно-частном партнерстве, муниципально-частном партнерстве в Российской Федерации и внесении изменений в отдельные законодательные акты Российской Федерации (Закон о ГЧП): Федеральный закон Российской Федерации № 224-ФЗ от 13.07.2015 г. (ред.

03.07.2016 г.) // СПС «КонсультантПлюс».

37. **Афонцев С.А.** Выход из кризиса в условиях санкций: миссия невыполнима? URL: http://inst itutiones.com/general/2562-vyxod-iz-krizisa-v-usloviya x-sankcij.html (дата обращения: 12.08.2016).

38. **Радушинский Д.А.** Коммуникационные центры как элемент институциональной среды инновационной экономики // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2015. № 5(228). С. 54–63. DOI: 10.5862/JE.228.5

39. **Бородин В.В., Васьков Н.Н., Калистратов Н.Я.** и др. О создании и развитии специализированной верфи «Арктика – шельф» // Арктика и Север. 2014. № 17. С. 14–21.

RADOUSHINSKY Dmitrii A. – St. Petersburg State Forestry Engineering University named after S.M. Kirov.

195251. Insitutskiy av. 5. St. Petersburg. Russia. E-mail: d.radoushinsky@gmail.com

РАДУШИНСКИЙ Дмитрий Александрович – доцент кафедры Санкт-Петербургского государственного лесотехнического университета им. С.М. Кирова, кандидат экономических наук.

195251, Институтский пр., д. 5, Санкт-Петербург, Россия. E-mail: d.radoushinsky@gmail.com

T.B. Rusakova, O.A. Saychenko

THE TRANSFORMING MONETARY FUNCTION OF GOLD IN THE MODERN GLOBAL CURRENCY SYSTEM

Т.Б. Русакова, О.А. Сайченко

ТРАНСФОРМАЦИЯ МОНЕТАРНОЙ ФУНКЦИИ ЗОЛОТА В СОВРЕМЕННОЙ МИРОВОЙ ВАЛЮТНОЙ СИСТЕМЕ

The process of gold demonetization fixed by the Jamaica Agreement is rather controversial, which has been confirmed by the 2008 financial crisis. This crisis can be considered a trigger for returning gold back to the world monetary system. With all these factors taken into account, it is necessary to review the status of gold in the modern currency system. That is why the subject of this paper is up-to-date and relevant to the current situation. The paper considers the modification of the gold's function, on the one hand, as a way to sort out the problems in the world monetary system; on the other hand, as a response to new gold market trends. In order to validate this hypothesis, the authors conducted a retrospective analysis of all available world monetary systems, and characterized the gold market using the principles of the systemic analysis. As a result, the authors found out the key trends of the gold market development, the main factors that determine a pricing trend in the post-crisis period. Revealing such potential instruments of using gold in the system of international payments and lending relations as "digital gold currencies", loans secured by gold, "gold loans", deposit interests paid in gold, the authors made a conclusion that gold keeps its function as a legal tender. The practice of quoting gold in USD has allowed to assume that gold still indirectly implements the function of account unit. The changing behavior of countries that are the owners of the main gold reserves, which now have now become gold buyers, and the aspiration of China, Russia and other developing countries to reallocate the world gold reserves confirm a new role of gold as global money. Thus, gold under circumstances of ongoing demonetization has actually gained the status of the most important international reserve asset. The above-stated conclusion is also supported by the decisions taken by IMF and other international organizations to regulate the gold market and to assign a new status to gold in the banking sector. The strengthening monetary functions of gold in the world currency system has brought back discussions about returning to the gold standard. This paper focuses on the arguments in favor of this proposal, and the factors impeding this process in modern conditions. However, the monetary functions of gold in the world currency system should stay a topic for debate, because the results of the study can be used for searching for effective ways to improve the world monetary system in order to make it more stable in the highly volatile global economy.

GOLD; WORLD GOLD MARKET; GOLD PRICE; GOLD RESERVE; GOLD MARKET TRENDS; GLOBAL CURRENCY SYSTEM; DEMAND AND SUPPLY; MONETARY FUNCTION OF GOLD; GOLD STANDARD.

Процесс демонетизации золота, закрепленный Ямайскими соглашениями, протекал и протекает противоречиво, что еще раз продемонстрировал финансово-экономический кризис 2008 г., создавший предпосылки для более активного возвращения золота в мировую валютную систему. С учетом этих факторов возникает объективная необходимость и актуальность пересмотра роли золота в современной валютной системе. Модификация роли золота рассмотрено, с одной стороны, как способ разрешения противоречий, возникающих в мировой валютной системе, а другой — как ответ на новые тенденции развития рынка золота. Для обоснования данной гипотезы проведен ретроспективный анализ всех существовавших мировых валютных систем и на основе принципов системного анализа охарактеризован рынок золота. Выявлены основные тенденции его развития, основные факторы, определяющие ценовой тренд в посткризисный период. Выявление таких перспективных инструментов применения золота в системе международных расчетов и кредитно-финансовых отношениях, как «цифровых золотых валют»,

кредитов под залог золота, выдачи «золотых кредитов», оплаты золотом процентов по депозитам, позволило сделать вывод о сохранении золотом функций средства обращения и средства платежа. Сложившаяся практика котировки золота в американских долларах − свидетельство того, что косвенно золото выполняет и функцию меры стоимости. Смена модели поведения стран, являющихся основными владельцами золотого запаса в мире и ставших сегодня покупателями золота, стремление Китая, России и других развивающихся стран к перераспределению мирового золотого запаса свидетельствуют о новой роли золота как мировых денег. Таким образом, золото в условиях сохраняющейся демонетизации фактически уже приобрело статус важнейшего международного резервного актива. Этот вывод подтверждается, в том числе, и решениями, которые принимаются Международным валютным фондом и другими международными организациями по регулированию рынка золота и закреплению нового статуса золота в банковской сфере. Усиление монетарных функций золота в мировой валютной системе сделало одним из главных дискуссионных вопросов предложение о возврате к золотому стандарту. Подробно рассмотрены аргументы в пользу данного предложения, а также факторы, которые не позволяют реализовать этот процесс в современных условиях. Тем не менее, монетарные функции золота в мировой валютной системе должны оставаться темой для обсуждения, а результаты проводимых исследований могут быть использованы для поиска эффективных направлений совершенствования мировой валютной системы в целях повышения ее стабильности в условиях высокой волатильности развития мировой экономики.

ЗОЛОТО; МИРОВОЙ РЫНОК ЗОЛОТА; ЦЕНА ЗОЛОТА; ЗОЛОТОЙ РЕЗЕРВ; ТЕНДЕНЦИИ РАЗВИТИЯ РЫНКА ЗОЛОТА; МИРОВАЯ ВАЛЮТНАЯ СИСТЕМА; СПРОС И ПРЕДЛОЖЕНИЕ; МОНЕТАРНАЯ ФУНКЦИЯ ДЕНЕГ; ЗОЛОТОЙ СТАНДАРТ.

The economic and geopolitical situation in the world is still a source of instability and uncertainty for the global currency system. Today the economic community tends to work out new operational principles for the world's financial system and to find new instruments for stabilizing it. However, history repeats itself. Therefore, discussions focus on gold as a monetary metal. As usual, when the global currency system faces serious challenges, the function and the status of gold in the international monetary relations has to be scrutinized. That is the reason why the problem raised in this paper is very important.

The purpose of this paper is to analyze the current state of the gold market and to identify the forms for modifying the function of gold in the conditions of world's economy fluctuations.

The present study is expected to solve the following tasks:
− to determine the main development trends for the gold market after the global economic crisis of 2008;
− to explain the relationship between banking operations on the gold market and the modification of gold's monetary functions;
− to study the application of "digital gold currencies" in international financial transactions and to identify their structural and functional features;
− to assess the proposals for introducing the elements of the gold standard into the world monetary system for stabilizing it.

For a long period of time the evolution of the global monetary system has been based on gold. At early stages of the evolution gold was used as the global legal tender and considered to be a single reserve asset. The Jamaica monetary system, which is used in today's reality, was ratified by the agreement on the Demonetization of Gold in 1978, which was approved by most IMF (International Monetary Fund) member countries. This agreement allowed switching from the gold-exchange standard to the monetary standard. This agreement cancelled the official value of gold and gold parities of national currencies. Thus gold lost its function of value unit, it stopped being the foundation for setting exchange rates and product prices.

Afterwards, gold was excluded from the sphere of international payments, including the gold payment of state quotas for the IMF. At that time the IMF granted a sixth part of its gold reserve to member-countries, which paid the IMF with their national currencies. According to the agreement, banknotes could not be converted into gold. The gold thus lost its function of the global means of payment, giving way to reserve currencies and the collective currency of the IMF (SDR). Legally, the demonetization of gold was finished, and countries obtained the right to choose any regime of exchange rate.

Formally, the world market of gold became free from state intervention. In addition, having lost its monetary functions, gold turned into a

precious metal which can be sold in the market. Today's market of gold is a cluster of external and internal markets that ensure a constant gold trade and gold-related financial instruments.

Modern gold markets accumulate the demand and supply of this metal, and trade it at a market price. The structure of the world gold market is based on the following major sources: forming demand (household and industrial consumption); investment and hoarding demand; speculative deals, purchase of gold by central banks to increase their gold currency reserves. The main element of the fabrication demand is from the jewelry industry. Major industrial groups of gold customers are electronics, aerospace industry, military engineering, medicine, etc. Today the main contribution to the aggregate demand for gold is made by investment and hoarding demands. Gold is a reliable and liquid asset for financial safe-keeping on behalf of investors into prospective financial assets and hoarding investors, who save money for a rainy day.

When it comes to the supply structure of the world gold market, it has the following basic components: extraction of primary gold, secondary gold (metal recycling); gold hoarding (sale of gold from government reserves). The dominating part of the gold market is supplied by the gold extraction industry which includes gold mining and refinery.

The world gold price results from pricing on specialized sites and financial markets. Today the dynamics of the world gold prices are determined by contradictory trends. After reaching the price minimum in April 2001, gold prices had been growing for 12 years. The peak price of gold was reached in 2011: $ 1923.7 per ounce. The market had never seen similar dynamics for any other asset. In 2012 the situation dramatically changed, and 2015 was the third year of a falling market trend. The average gold price in the first half of 2015 amounted to approximately $ 1187 per ounce with the peak price of $ 1300 per ounce in February, then reaching its 5-year minimum of $ 1076 per ounce in July [19, p. 152]. Table presents the dynamics of .

Gold Price Dynamics, USD:
% of the annual change [9]

Year	2011	2012	2013	2014	2015
Annual change, %	10.1	7.0	−28.3	−1.5	−10.4

Experts point out several reasons for the decrease in world gold prices: structural changes in the demand for gold in favor of the investment one; active manipulation of gold prices on behalf of Western monetary authorities through investment banks; significant revaluation of gold prices, leading to the activation of speculators [10, p. 2]. Some experts expect gold prices to level off gradually, then potentially turning into steady growth. Thus, in the first quarter of 2016 the price rose to $ 1182 per ounce [9].

Taking into account all of the above, we can conclude that it is getting increasingly difficult to analyze the situation on the gold market, compared to any previous, even favorable, period.

Thus, gold demonetization led to the extension of gold usage. All over the world gold is used as a raw material, financial asset (in bars and coins), basic asset (in securities), financial instrument. This fact is proved by all economists.

The controversy lies in the issue of whether gold will remain monetary or not. For instance, Bunkina and Semenova state that gold is only a commodity of high luquidity in the modern monetary system, used for industrial and investment purposes [2, 3].

Their opponents are Krasavina, Smyslov, Bylinyak, Anikin and others who believe that gold still implements monetary functions, but in a modified form [1, 4, 16].

In our opinion, the second view reflects more accurately the status of gold in the modern monetary system.

Firstly, after its demonetization gold formally ceased to fulfil its functions as a unit of account. Prices of all goods in international economic transactions are expressed in USD or euro. Besides, a market price of gold itself is historically quoted in dollars. Therefore, any fluctuations of the dollar affect the gold price. It implies that an increase in the gold price can be considered not only a factor in making this precious metal more expensive, but as the devaluation of the currency it is pegged to. In particular, Stadnichenko claimed that the gold market is responsible for the exchange of paper money into gold and vice versa. It determines whether paper money is in compliance with its parity. Developing this idea, Alferov and Navoy

confirm it with statistics showing similar growth rates of gold quotations and money supply in USD [20, p. 55].

Secondly, gold is not formally used as a legal tender for international transactions. The evolution of the internet and telecommunications allowed using the so-called "digital gold currencies' (DGC) for international payments. These currencies are secured by gold reserves and called private, as they are not emitted by governments. The unit of account for such a currency is ounce or a gram of gold.

Gold&Silver Reserve, Inc. was the first company to introduce the E-Gold international monetary system in 1996. The e-Bullion, Pecunix, GoldMoney, etc., are similar e-banking systems. Each of them can be used to transfer sums secured by an amount of physical gold. This feature makes the system effective for international payments, as user accounts are not pegged to any national currency. Using digital gold, it is possible to participate in online auctions and trades, e.g., E-bay, to do e-commerce, to pay services, to participate in charity, to invest into various profitable projects. DGC is popular, because it is secured by real values and protected against inflation, deflation, errors of monetary authorities; it is not pegged to national currencies, it has low operational costs and guarantees fast payments, high liquidity, etc.

However, using DGC, the same as using other currencies, has its own risks. All of them are caused by a lack of international regulation. The emission of e-money and its profitability are secured by only the emitent, not by the state. It leads to the fact that it is inadvisable to use DGC for major payments, and also for accumulating large sums within a long-term period. There is also a serious risk of losing e-data, because DGC is stored in electronic form, and fully depends on reliability of storage and control over the information transfer. Therefore, DGC security depends on both the security of providers and the security of account-holder's computer. In 2002 the Global Digital Currency Association (GDCA) was established. It united all currency operators and various users, expanding the area of DGC usage by finding solutions for correcting errors made by the companies emitting e-gold. GDCA exemplifies a self-regulation attempt of the e-gold industry.

Russia passed the Federal law No. 161-FZ 'On the National Monetary System' on June 27, 2011. This law granted a legitimate status to e-money, making it equal to other legal tenders. However, e-banking systems pegged to the gold price are not still available in Russia [6].

In our opinion, DGC could become one of the main monetary forms, provided an effective institutional ground and higher information security are ensured by governments for the DGC market. This will allow gold not only to reclaim its monetary functions, but to work as a unit of account.

Thirdly, the function of money as a legal tender stimulated the transition to credit money, which subsequently replaced gold in currency circulation channels. However, gold still keeps this function today in currency and financial relations. Nowadays, there is a practice of allowing loans to banks on security of gold, allowing 'gold credits', deposit interest payments with gold.

The demand for gold abroad is usually shown by specialized branches, primarily, the gold-mining industry. They can be used to develop the industry itself, because the gold content in the rocks is decreasing as the most profitable deposits are being depleted. It is one of the reasons for the increasing cost of the production of gold. On the other hand, gold-miners can be interested in gold loans with respect to hedging, since these loans can help fix the price of precious metals in case of its reduction. The most profitable period of loan transactions in gold for gold-mining companies is a rise in the prices of the precious metal, which gives them the opportunity to sell the metal that has not been extracted yet at a higher price. Gold loans for commercial banks are an additional income source.

Currently, one of the most in-demand transactions is allowance of loans by banks on security of gold. The implementation of this transaction requires commercial banks to carry out an expert check of the gold, accept it in deposits, and guarantee safety during the concluded transaction.

The Central Bank of the Russian Federation introduced a credit facility for banks on security of gold in post-crisis 2011. At that time banks received only 19 million rubles of loans. But as

early as in 2012, the figures dramatically rose to 2.15 billion rubles at once. In 2013 and 2014, loan rates on security of gold were slightly lower than in 2012, amounting to 2.1 billion and 2 billion rubles respectively. But it is logical, since before the start of the crisis in 2014 banks mostly borrowed money from the Central Bank within the framework of more popular repos (loans against securities) and credits against non-marketable assets (including bills and guarantees of other banks). Rates of liquidity there, provided by the Central Bank, are measured in trillions. According to the latestdata of the Central Bank, as of December 1, 2014, the contract with it on the allowance of loans on security of gold was signed by 42 Russian banks, the names of which are not revealed on its website [13].

The growing acceptance of gold as a pledge in regulated markets, on the one hand, and the global financial crisis of 2008, on the other hand, made international organizations regulating the worlds largest financial organizations reconsider the role of gold in the banking sector. For instance, the Basel Committee on Banking Supervision introduced a new document, Basel III, which pays a great deal of attention to gold as a bank asset. The Committee was established at the Bank for International Settlements in Basel by the heads of central banks from ten countries (G10) at the end of 1974 to develop general international rules in the banking supervision sector after breaking the balance in international banking and foreign exchange markets, caused by the bankruptcy of the Herstatt bank in Western Germany. The proposals of Basel III were approved at the G20 Summit in November, 2010 [15].

According to this document, gold is transferred to the banking capital of tier-1 at 100 % price and banks get the opportunity to replace their paper assets (mostly U.S. Treasury bonds) with this metal. According to the previous Basel standards, equity capital of high quality was only cash money (which belongs to the legal tender category in all countries) and government debt securities (primarily, bonds of treasuries and bonds of the U.S. Treasury). Switzerland is promoting a project introducing a parallel currency inside the country in the form of the golden frank.

Thus, gold can be used more widely to pay off bank obligations and to turn into a highly liquid financial asset. Ben Bernanke, Chairman of the U.S. Federal Reserve, did not agree with the growing importance of gold in forming equity capitals of banks and noted again that gold is not the best kind of money. Bernanke's motives are unclear but it is hard to deny that new solutions of Basel III are a threat to the U.S. dollar and the American economy. Apparently, that explains the refusal of the USA and its allies in Europe to start the transition to the new standard of forming equity capitals of banks.

The Basel III project, in our view, demonstrates increased attention to gold as a monetary metal. Thus, gold is still used in international lending transactions.

Also, today there are tendencies in monetary and financial relationships which can be considered to be a return of gold to the global currency system. And again, these tendencies are connected with the financial and economic crisis of 2008. It revealed a number of global problems which are not solved yet and, consequently, create all the prerequisites for volatility of the global currency system and economy [10]. They can include retention of innovations on the financial market and uncontrolled use of derivative financial instruments in particular; imperfection of the flexible exchange rates and their volatility; absence of a regulating global financial regime that could keep the role of international financial markets as an independent regulator of the world's economy; the increase in the USA's national debt as a result of the policy stimulating composite demand that is highly likely to weaken, which creates risks for holders of this value all over the world, etc. The problem of maintaining international liquidity was also acute during the crisis. International banks suddenly faced the scarcity of dollars. Firms started hoarding liquidity. In these circumstances, public sector liquidity replaced private sector liquidity. Thus, the role of gold and forex reserves became more important.

Apart from reserve currencies, special drawing rights, and reserve assets in IMF, gold and forex reserves include the gold reserve of a country. This official gold reserve is stored in the form of bars or coins in the Central Bank and

state financial institutions or in international monetary financial organizations. Its purpose is to mobilize international payment instruments by selling gold for foreign currency and using it as a pledge to get foreign loans.

The formation of the gold reserve of a country has been long influenced by the IMF position, secured with the Jamaica Agreement, a relatively low price of gold, the reign of the U.S. dollar in the global currency system, the wish of the European countries to diversify their gold and forex reserves after excluding gold from the world money. It explains the behavior of central banks in the gold market in the 1980−1990s. The majority of them were net sellers. In the last few years, due to the global economic crisis, the behavior of the central banks in the gold market has started to change. From net sellers they became net buyers. In 2012, 12 % of the global composite demand for gold accounted for central banks (10 % in 2011), they bought 534.6 tons of the metal in the market. Overall, by the end of 2012, according to IMF estimations, almost 31.6 thousand tons of gold were stored in central banks [8]. The demand for gold remained high even in 2013, when gold prices fell due to the implementation of the quantitative easing program by the U.S. Federal Reserve System. However, in spite of expectations of analysts, central banks did not sell gold from their reserves. On the contrary, despite the decrease by 32 % central banks remained stable buyers of gold. Net purchases of 409 tons of gold were documented in 2013. It is about one fifth of all the gold that was ever extracted in the modern history of mankind [11]. The tendency of central banks to buy gold is still present, according to the World Gold Council (WGC).

Despite the fact that not only developed but also developing countries actively participate in buying gold, the greater part of the official reserves is, however, concentrated in developed countries and international monetary organizations.

According to the World Gold Council, by January, 2016 the USA had the largest gold reserve. It accounted for 8 133.5 tons. Germany holds the second place. Its reserve accounted for 3381 tons. The third place is held not by a state but the International Monetary Fund, the amount of its gold is 2814 tons. The fourth place

is taken by Italy (2451 tons). The fifth place is held by France with the gold reserve of 2435 tons. The sixth place is taken by the rapidly developing China. The amount of gold in its state depositories amounted to 1658.1 tons. The seventh place is held by Russia. Within just 15 years, the gold reserve of the country increased from 384.4 to 1275 tons. It is an incredible growth rate in figures, which was shown only by China. This tendency indicates an obvious strengthening of Russia on the global economic arena. The parts of gold in the total supply of international reserves are 73.3 % in the USA, 67.4 % in Germany, 65.7 % in Italy, and 60.7 % in France [14]. Thus, the main emitents of reserve currencies store a significant part of their gold and forex reserves in gold. Perhaps, this distribution reveals the 'hidden' securement of their currency emission.

Another new tendency in the global currency system, confirming the enhanced role of gold, became the recovery of gold assets by central banks from depositaries in other central banks, undertaken by Venezuela and Germany.

When estimating the role of gold as world money, it is not possible to forget that the European Monetary System (EMS) is based on partial use of gold in the transactions between central banks and European monetary institutions. In 1998, 20 % of gold reserves of the EMS member countries served as partial securing of the ecu issue and since 1999 of the euro issue.

There are numerous reasons for the changing role of central banks in the gold market. Let us list some of them.

1. Increased volatility of exchange rates, an increasing level of currency and credit risks, connected with debt crisis in Europe, caused a growing demand of central banks for diversification of their official reserve assets.

2. Reserve currencies today are just symbols of value, secured with trust of investors. When this trust is undermined due to sometimes unreasoned decisions of monetary authorities, their purchasing power starts to drop. Under such conditions, only gold, which has an intrinsic value, becomes the full-fledged form for storing national savings.

3. Unfortunately, the application of economic sanctions and freeze of economic assets are signs

of today's global economic development. The increasing share of gold in the gold and forex reserves ensures political safety under conditions of some countries applying sanctions.

4.Gold gives central banks an opportunity to manage a portfolio of gold and forex reserves, choosing less risky operations with small returns. The most common operations are swap operations, loans with gold (gold lease), and deposit operations. Central banks use their gold reserves not only to enlarge revenues but also as pledged assets, which can be transferred to other states when getting a loan or purchasing goods; as a source of repayment of external public debts; as a tool for import operations; as a reserve fund for buying foreign currency in case of urgent necessity; as a resource for financing deficit of payment and trade balances or overcoming default.

Thus, the main role of the gold reserve practically has not changed: gold, remaining a highly liquid asset in reserves of a state, can be mobilized in case of a crisis and used to settle necessary accounts. For this very reason, gold reserves of many countries keep being replenished under conditions of increased volatility of global economic and currency systems. As a result, Krasavina states, the future of gold will depend on how international monetary organizations resolve today's contradiction between gold being officially expelled from the Jamaica Monetary System and its actual use as an international reserve asset [18, p. 36]. To estimate the prospects of gold in the reforming global currency system, it is necessary to take into account the current Washington Agreement on Gold, which is revised every 5 years.

In September, 1999, an agreement was signed in Washington between 17 central banks, including the European Central Bank (ECB), on sales of gold for a period of five years. It subsequently got the name 'The First Washington Agreement on Gold'. It was officially stated that this agreement had a purpose of restraining sales of the yellow metal by central banks in order not to bring the gold market down. The limits of sales were set for certain countries and 2 thousand tons of the metal were planned to be sold on the market. In September, 2004, the agreement was renewed

with new norms of sales set for certain members. It became 'The Second Washington Agreement on Gold'. Finally, in September, 2009, 'The Third Washington Agreement on Gold' emerged. However, in 2009, at the height of the financial crisis, central banks turned into net buyers of gold. To stabilize the gold market, on May 9, 2014, the European Central Bank and 20 other central banks of Europe announced signing the fourth interbank agreement on gold. This agreement, which came into force on September 27, 2014, will be enforced for five years. The banks parties to the agreement commit themselves not to sell large amounts of gold.

To clarify the intentions towards their gold assets, the parties of the fourth agreement stated that gold remains an important element of the global monetary reserves. It is also noted in the agreement that they will keep coordinating their transactions with gold to avoid upsetting the markets and that currently they do not have plans of selling considerable amounts of gold. Thus, the agreement is supposed to protect markets from destabilization through actions of central banks with considerable gold reserves.

From a practical standpoint, the solution to this problem implies strengthening the legal framework regulating sales and transactions with gold of central banks and oriented at decreasing price volatility, since none of the central banks today are interested in sharp turnabout in prices on the gold market.

Today, private and corporate investors tend to accumulate gold as a medium for securing their wealth, to protect against inflation and currency fluctuations, to diversify their savings. Gold still attracts investors by its high liquidity and value. The object of investing can be gold bars of special size. These bars of gold are called banking or standard. They have a high value. Therefore, the general public prefers gold bullion bars, the weight of which is not specified.

During economic crises private investors tend to increase the demand for investment gold coins which replace an amount of their investment in foreign currencies. Thus, after the 2008 recession spending on such coins showed a sharp increase, which led to the rise in production, with new gold coin trading sites emerging. For instance, in May 2016 the Russian Trading System (RTS Board) launched Bullion Coins, a new sector of

78

the over-the-counter (OTC) market. This sector is expected to unite sellers of investment and commemorative coins, credit and non-credit institutions, private investors. Earlier these instruments could be acquired only in banks or from private dealers. Trading objects on this market are over 200 series of investment and commemorative coins, classified according to Mints. They comprise all investment coins emitted by the Central Bank of Russia, including gold and silver coins 'Saint George the Victorious', gold coins 'Sochi 2014', etc. Additionally, the new section of the RTS Board also offers foreign coins, such as the American 'Buffalo', the Canadian 'Maple leaf', the Australian 'Kangaroo', the South African 'Krugerrand', the Austrian the 'Philharmonic', the Belarusian 'Slavyanka' and the Kazakh 'Tiger'.

Another form of investing in gold today is opening impersonalized metal bank accounts by private investors. These are similar to urgent deposits for physical entities. The only difference is that an amount of gold on these accounts is regulated.

Every form of investing in gold has its own advantages and disadvantages. As a whole, in our opinion, a variety of private investments in gold, which is offered by the monetary system, can ensure the monetary function of gold as a medium of accumulation in the conditions of unstable market and currency systems.

Finishing with monetary functions of gold, let us concentrate on another problem. During a long period of time, global financial and political crises give many scholars reason to promote the idea of return to the gold standard in the global currency system. Many well-known economists, including Nobel laureate and philosopher Friedrich von Hayek [5], Paul Fritz [12], Alan Greenspan [7], and others call for strengthening the role of gold in currency systems on national and global levels. Articles on this subject are still written even in the 21st century [17].

The strongest argument for the revival of the gold standard became the lost trust of investors in reserve currencies and primarily the U.S. dollar.

Certainly, return to the gold standard can ensure greater stability for the current global currency system. For example, banks will not be able to afford unpredicted risks because they will have to back a currency with gold to avoid bankruptcy. Supporters of the gold standard note that using it prevents inflation, because under the gold standard the government cannot implement currency emission that is not backed with gold. The gold standard contributes to levelling off trade balances and also ensures intensification of the world trade and capital mobility, decreases the volatility of currency rates.

Nevertheless, today the shift to new models of the gold standard faces a great number of difficulties. The main of them is that none of the unique commodities cannot function as world money in the context of developed world economy due to quantitative restrictions of this commodity and its uneven distribution among countries.

A country's money supply and monetary base change if necessary, thereby regulating macroeconomic processes. Under the gold standard, the supply of a national currency strictly depends on the amount of gold in the central bank reserves, and a corresponding additional gold supply is required to create new money, but the extraction of gold in the world is very limited. Therefore, any product standard will restrain economic development, causing economic and monetary crises. Moreover, there are problems of gold sales on the world market. Any attempts of selling a considerable amount of monetary gold lead to a fall in its prices and destabilize the market, reducing the value of gold reserves of a country. Also, the 'Gold Discipline' would impede any anti-crisis measures and involve more industries and countries into the crisis. The gold standard would turn out to be short-lived and under critical circumstances it would have to be abolished, which would increase the general economic instability.

Besides, under the conditions of constantly changing macroeconomic environment, volatility is also present in the gold market. It emerges due to economic crises, speculations, global instability, and other processes. Meanwhile, stability of the golden standard system greatly depends on the stability of gold prices. In other words, any change in the price of gold with respect to prices of commodities leads to inflation or deflation. For instance, if gold prices

go up, the value of issued money increases as well and this causes deflation and a cut in the prices of commodities.

The gold standard does not always lead to decreasing disproportions of payments and trade balances. There are always countries with a surplus of current accounts of payment balance in the global currency system. They are not obliged to issue money when getting gold externally. They may continue to accumulate liquid gold reserves, especially while waiting for gold prices to rise. Most likely, it will result in a situation when gold reserves are mostly concentrated in countries with positive balance and the global currency system will collapse due to the absence of gold reserves in some states parties.

Finally, owning gold today becomes an object of tough competition between central banks of economically developed countries and of countries with developing market economies as well. However, the gold standard implies strictly following the general rules. It is unlikely that countries like the EU, the USA, Japan, and the BRICS countries will work alongside, sacrificing their economic development, because modern competition in the world trade is based not only on labor productivity, capital capacity of production, and scientific and technological superiority, but can be adjusted with undervaluation or overvaluation of the national currency exchange rates. At the time of financial difficulties, a country can slightly devaluate its currency by stimulating export, which provokes currency wars between the countries. Thus, the competition between countries is unlikely to allow introducing the gold standard.

Thus, in our view, the listed difficulties today will not allow considering the gold standard as a potential instrument for maintaining the stability of the global currency system.

Nevertheless, the role of gold in the global currency system should be strengthened. It is possible due to including gold into the SDR. Due to the negative correlation dependence of gold and the U.S. dollar, this step would allow stabilizing the SDR properties and enhance the role of gold in the global currency system.

The analysis, given in the paper, allows drawing the following conclusions.

1. Crisis upheavals of the world's economy were constantly initiating the occurrence and domination of the new function of gold, which predetermined its role in the global currency system.

2. The gold market was forming and developing along with the evolution of the global currency system and depended on the monetary role of gold in the global economic system.

3. In the last twenty years, despite flourishing financial instruments and their derivatives, gold has not lost its unique quality of almost absolute liquidity.

4. The extension of gold usage by central and commercial banks and current global electronic systems of digital gold allow clearly observing the modern transformation of such functions of gold as an exchange or a legal tender.

5. The conversion of central banks from net sellers to net buyers and diversification of income sources from gold transactions are the evidence of the enhanced role of gold in international finances. In this connection, under the conditions of the world's economy globalization and aggravation of international competition, the problem of regulating the international liquidity obtains a new meaning. Managing official reserve assets not only becomes the most important macroeconomic task of state regulation but also becomes global. Gold is considered one of the assets which can be a factor of overcoming the crisis potential of the Jamaica Monetary System.

6. Reforming the modern currency system is impossible without specification of the status of gold as an international reserve asset. Moreover, taking into account the increased volatility of gold prices, strengthening the gold sales regulation in the market is required from international financial institutions.

7. Reestablishing the gold standard in the modern context is impossible on a full scale because the economy suffers from constant fluctuations, overcoming which requires the growth of active money; modern production volumes are increasing, gold is still allocated between countries unevenly.All the gold in the world, both already extracted and stored in depositaries, and that is yet to be extracted will not be enough for servicing the international flows under these conditions.

REFERENCES

1. **Anikin A.V.** Zoloto. M.: Mezhdunarodnye otnosheniia. 1984. 344 s. (rus)

2. **Bunkina M.K.** Valiutnyi rynok : monografiia. M.: DIS, 1995. 110 s. (rus)

3. **Bunkina M.K., Semenov A.M.** Osnovy valiutnykh otnoshenii: ucheb. posobie. M.: Iurait. 2000. 192 s. (rus)

4. **Krasavina L.N., Smyslov D.V., Byliniak S.A.** i dr. Mezhdunarodnye valiutno-kreditnye i finansovye otnosheniia: uchebnik. M.: Finansy i statistika. 2005. 576 s. (rus)

5. **Khaiek F.A.** Chastnye den'gi. M.: Institut natsional'noi modeli ekonomiki. 1996. 216 s. (rus)

6. O natsional'noi platezhnoi sisteme RF: Feder. zakon № 161-FZ ot 27.06.2011 g. URL: http://docs.cntd.ru/document/902286143 (data obrashcheniia: 10.05.2016). (rus)

7. **Grinspen A.** Zoloto i ekonomicheskaia svoboda. URL: http://libertynews.ru/node/569 (data obrashcheniia: 05.06.2016). (rus)

8. Zoloto. Spros. Tendentsii. Polnyi god 2012. URL: http://www.gold.org/supply-and-demand/gold-demand-trends/back-issues/gold-demand-trends-full-2016-2013 (data obrashcheniia: 22.05.2016). (rus)

9. Zolotye tendentsii sprosa. URL: http://www.gold.org/supply-and-demand/gold-demand-trends (data obrashcheniia: 30.06.2016). (rus)

10. **Krivoruchko E.V.** Vliianie mirovogo finansovogo krizisa na rynok zolota. URL: http://www.e-rej.ru/Articles/2010/Krivoruchko.pdf (data obrashcheniia: 28.06.2016). (rus)

11. Leto 2014 g.: Tsentrobanki pokupaiut zoloto. *Gold.ru*: informatsionno-analiticheskii sait. URL: http://gold.ru/news/leto-2014-goda-centrobanki-pokupajut-zoloto.html (data obrashcheniia: 20.05.2016). (rus)

12. **Paul' Frits.** Neminuemyi krakh dollara. URL: http://polite.com.ua/libraru (data obrashcheniia: 16.06.2016). (rus)

13. TsB rasshiril chislo bankov, pretenduiushchikh na kredity pod zalog imushchestva. URL: http://izvestia.ru/news/582118 (data obrashcheniia: 29.05.2016). (rus)

14. Central banks and other institutions. URL: http://www.gold.org/supply-and-demand/gold-demand-trends (data obrashcheniia: 09.06.2016).

15. Group of Governors and Heads of Supervision announce signer global minimum capital standards Bloomberg. URL: http://www.webcitation.org/6B3nZiljf71 (accused May 19, 2016).

16. **Byliniak S.A.** Disbalans v mirovoi ekonomike. *Iugo-Vostochnaia Aziia: aktual'nye problemy razvitiia.* 2011. № 16. S. 20−32. (rus)

17. **Dzhanataev Taken.** Mirovaia valiutnaia sistema: vozvrashchenie zolotogo standarta? *Vestnik Sankt-Peterburgskogo universiteta. Seriia 5. Ekonomika.* 2013 № 2. S. 49−62. (rus)

18. **Krasavina L.N.** Kontseptual'nye podkhody k reformirovaniiu mirovoi valiutnoi. *// Den'gi i kredit.* 2010. № 5. S. 48−57. (rus)

19. **Nikulin A.A.** Mirovoi rynok zolota: sostoianie i perspektivy razvitiia. *Problemy natsional'noi strategii.* 2015. № 1/13. S. 151−174. (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Аникин А.В.** Золото. М.: Международные отношения. 1984. 344 с.

2. **Бункина М.К.** Валютный рынок : монография. М.: ДИС, 1995. 110 с.

3. **Бункина М.К., Семенов А.М.** Основы валютных отношений: учеб. пособие. М.: Юрайт. 2000. 192 с.

4. **Красавина Л.Н., Смыслов Д.В., Былиняк С.А.** и др. Международные валютно-кредитные и финансовые отношения: учебник. М.: Финансы и статистика. 2005. 576 с.

5. **Хайек Ф.А.** Частные деньги. М.: Институт национальной модели экономики. 1996. 216 с.

6. О национальной платежной системе РФ: Федер. закон № 161-ФЗ от 27.06.2011 г. URL: http://docs.cntd.ru/document/902286143 (дата обращения: 10.05.2016).

7. **Гринспен А.** Золото и экономическая свобода. URL: http://libertynews.ru/node/569 (дата обращения: 05.06.2016).

8. Золото. Спрос. Тенденции. Полный год 2012. URL: http://www.gold.org/supply-and-demand/gold-demand-trends/back-issues/gold-demand-trends-full-2016-2013 (дата обращения: 22.05.2016).

9. Золотые тенденции спроса. URL: http://www.gold.org/supply-and-demand/gold-demand-trends (дата обращения: 30.06.2016).

10. **Криворучко Е.В.** Влияние мирового финансового кризиса на рынок золота. URL: http://www.e-rej.ru/Articles/2010/Krivoruchko.pdf (дата обращения: 28.06.2016).

11. Лето 2014 г.: Центробанки покупают золото // Gold.ru: информационно-аналитический сайт. URL: http://gold.ru/news/leto-2014-goda-centrobanki-pokupajut-zoloto.html (дата обращения: 20.05.2016).

12. **Пауль Фриц.** Неминуемый крах доллара. URL: http://polite.com.ua/library (дата обращения: 16.06.2016).

13. ЦБ расширил число банков, претендующих на кредиты под залог имущества. URL: http://izvestia.ru/news/582118 (дата обращения: 29.05.2016).

14. Central banks and other institutions. URL: http://www.gold.org/supply-and-demand/gold-demand-trends (дата обращения: 09.06.2016).

15. Group of Governors and Heads of Supervision announce signer global minimum capital standards Bloomberg. URL: http://www.webcitation.org/6B3n Ziljf71 (дата обращения: 19.05.2016).

16. **Былиняк С.А.** Дисбаланс в мировой экономике // Юго-Восточная Азия: актуальные проблемы развития. 2011. № 16. С. 20—32.

17. **Джанатаев Такен.** Мировая валютная система: возвращение золотого стандарта? // Вестник Санкт-Петербургского университета. Серия 5. Экономика. 2013 № 2. С. 49—62.

18. **Красавина Л.Н.** Концептуальные подходы к реформированию мировой валютной системы // Деньги и кредит. 2010. № 5. С. 48—57.

19. **Никулин А.А.** Мировой рынок золота: состояние и перспективы развития // Проблемы национальной стратегии. 2015. № 1/13. С. 151—174.

RUSAKOVA Tat'iana B. — Peter the Great St. Petersburg Polytechnic University.
195251. Politechnicheskaya str. 29. St. Petersburg. Russia. E-mail: tatuana0310@rambler.ru

РУСАКОВА Татьяна Борисовна — доцент Санкт-Петербургского политехнического университета Петра Великого, кандидат экономических наук.
195251, ул. Политехническая, д. 29, Санкт-Петербург, Россия. E-mail: tatuana0310@rambler.ru

SAYCHENKO Ol'ga A. — Peter the Great St. Petersburg Polytechnic University.
195251. Politechnicheskaya str. 29. St. Petersburg. Russia. E-mail: dean-office@igms.info

САЙЧЕНКО Ольга Анатольевна — доцент Санкт-Петербургского политехнического университета Петра Великого, кандидат экономических наук.
195251, ул. Политехническая, д. 29, Санкт-Петербург, Россия. E-mail: dean-office@igms.info

N.S. Lukashevich, D.A. Garanin

ANALYTIC DECISION SUPPORT SYSTEM
FOR SMALL BUSINESS CREDITING

Н.С. Лукашевич, Д.А. Гаранин

ИНФОРМАЦИОННО-АНАЛИТИЧЕСКАЯ СИСТЕМА ПОДДЕРЖКИ
# ПРИНЯТИЯ РЕШЕНИЙ О КРЕДИТОВАНИИ
СУБЪЕКТОВ МАЛОГО ПРЕДПРИНИМАТЕЛЬСТВА

The article develops the problem of credit process management and credit decisions support for small businesses. The official data on crediting and defaulted debt of small businesses is presented and analyzed. A higher growth rate of defaulted debt for small businesses indicates a lower efficiency of applied methods for credit risk assessment and management. For credit process management it is rational to apply (credit) decision support systems. The article systematized the specifics of small business crediting. The key feature is the high level of uncertainty in making credit decisions due to the frequent changes in the regulatory and legal information, a wide range of interpretation of the results of financial ratios analysis, incomplete information because of special (simplified) tax regimes. Taking into consideration specifics of small business crediting, the article proposes requirements for developing decision support systems and a group of tasks which are advisable to implement as system functions. The article systematizes the key decisions (tasks) to be taken at different stages of thr credit process for small businesses and contains a literature review of models and techniques developed and adapted to support decision-making on small business crediting. The majority of the models and techniques discussed in the study were designed or adapted for the Russian conditions and specifics of small business crediting. A composition of the major functional subsystems of the decision support system currently under development is proposed in the article. One of the distinguishing features of the decision support system is the application of hybrid techniques for adapting to both the expert-oriented credit departments and the departments focused on credit history information processing.

CREDITING; SMALL BUSINESS; CREDIT PROCESS; CREDIT RISK; DECISION SUPPORT SYSTEM.

Исследование развивает проблемы управления кредитным процессом и принятия кредитных решений для субъектов малого предпринимательства. Представлены и проанализированы официальные данные по объемам кредитования и просроченной задолженности субъектов малого предпринимательства. Опережающие темпы роста просроченной задолженности свидетельствуют о недостаточной эффективности применяемых методов оценки и управления кредитным риском. Для управления кредитным процессом целесообразно применять системы поддержки принятия (кредитных) решений. В исследовании систематизированы особенности кредитования субъектов малого предпринимательства. Ключевой особенностью является высокий уровень неопределенности при принятии кредитных решений в силу частых изменений нормативно-правовой информации, широкого спектра толкования результатов коэффициентного анализа финансовой отчетности, неполной информационной обеспеченности ввиду применения специальных (упрощенных) режимов налогообложения. На основе анализа содержательной специфики кредитования субъектов малого предпринимательства предложены требования к разработке систем поддержки принятия решений и комплекс задач, который целесообразно реализовать в качестве функционала. Систематизированы ключевые решения (задачи), которые необходимо принимать на различных этапах кредитного процесса для субъектов малого предпринимательства. Проведен обзор моделей и инструментов, разработанных и адаптируемых для поддержки принятия решений о кредитовании субъектов малого предпринимательства на различных этапах кредитного процесса. Преимущественно рассмотрены инструменты и модели, разработанные или адаптированные для российских субъектов малого или среднего предпринимательства. Предложен состав основных функциональных подсистем системы поддержки принятия решений о кредитовании субъектов малого предпринимательства. Одной из отличительных особенностей системы поддержки принятия решений является использование гибридных методов, позволяющих адаптироваться как экспертно-ориентированным кредитным отделам, так и на отделам, ориентированным на обработку массивов информации об исходах кредитных обращений.

КРЕДИТОВАНИЕ; МАЛОЕ ПРЕДПРИНИМАТЕЛЬСТВО; КРЕДИТНЫЙ ПРОЦЕСС; КРЕДИТНЫЙ РИСК; СИСТЕМА ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ.

Introduction. Small business, which is seen as a way for the development of the national economy, is one of the priorities in the current economic conditions. Against the background of creating an economic environment conducive to the development of small business, crediting
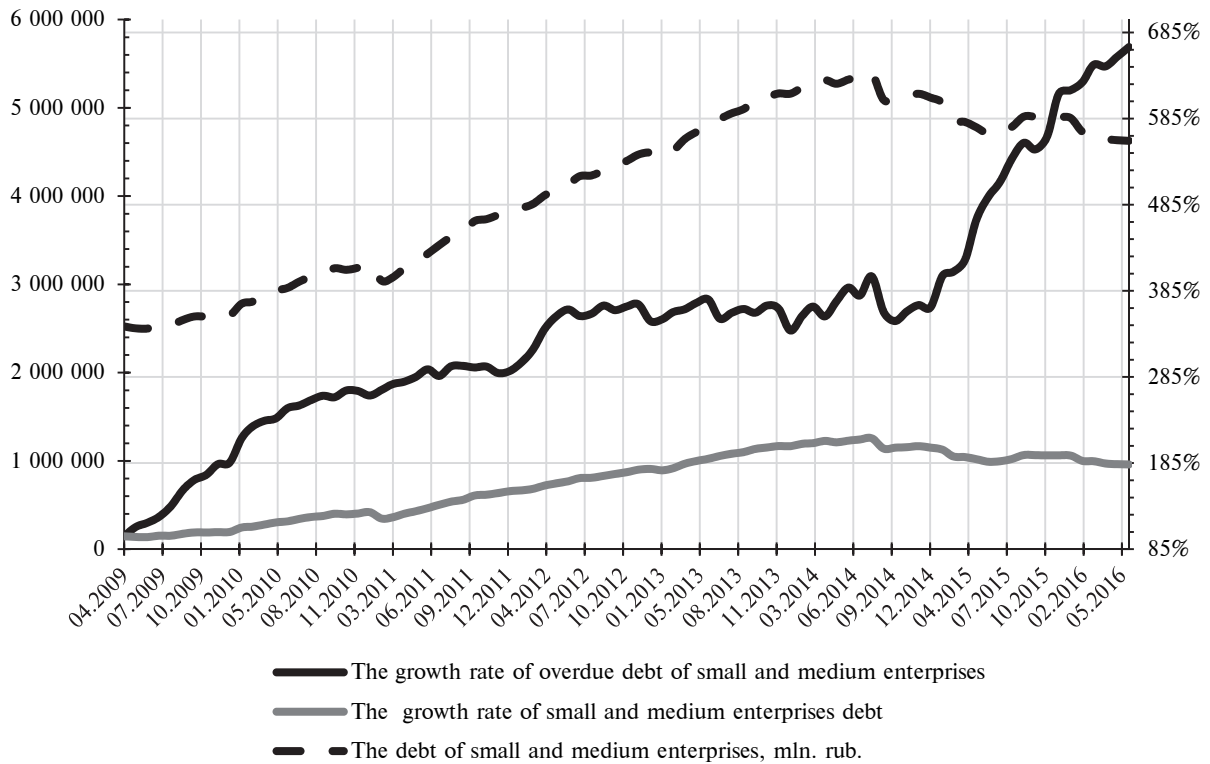
Fig. 1. Data on small and medium enterprises debt
Source: Our calculations were based on data of the National Bank of Russia

remains a constantly relevant issue, as evidenced by the desire of banks to increase credit portfolios and offer a variety of credit products. There is a trend of growing interest in the issues of the validity of the credit and investment decisions for small businesses.

According to the National Bank of Russia[1], the credit portfolio of small business for the first half of 2016 lost about 250 billion rubles (Fig. 1). During this period, negative trends remained in the market of small business crediting: the credit portfolio continued to decline, while the level of defaulted debt has exceeded 15 % of the credit portfolio (Fig. 2).

The deterioration of the situation is most evident in the segment of small and medium-sized banks: the level of defaulted debts in banks not included in the ranking (TOP-30) calculated by total assets value has grown almost by 2 times over the last 12 months and on June 1, 2016 exceeded 16 % of the credit portfolio. On the contrary, after declining for almost the entire year

of 2015, the share of the thirty largest banks in the portfolio of small business credits remained fairly stable for the first half of 2016 and accounts for about 56 % of the portfolio. A higher growth rate of small business defaulted debts shows a lack of efficient applied methods for credit risk assessment and management. Problems arise due to the specifics of small business crediting, so banks need specially designed models and approaches to credit process management.

For the assessment and selection of borrowers, as well as for credit process management, it is rational to apply the (credit) decision support systems, based on different groups of methods, the difference between which lies in the nature of the data, its accuracy and completeness, the method of factor aggregation and comparison of alternatives.

The aim of the study is to propose the architecture and requirements for (credit) decision support system based on the analysis of the distinctive features of small business crediting, as well as to make an overview of the models and tools developed and adapted to support the decision-making process on crediting at different stages of the credit process.

---

[1] Information about the outside and placed funds. URL: http://www.cbr.ru/statistics/?PrtId=sors (accused August 10, 2016).
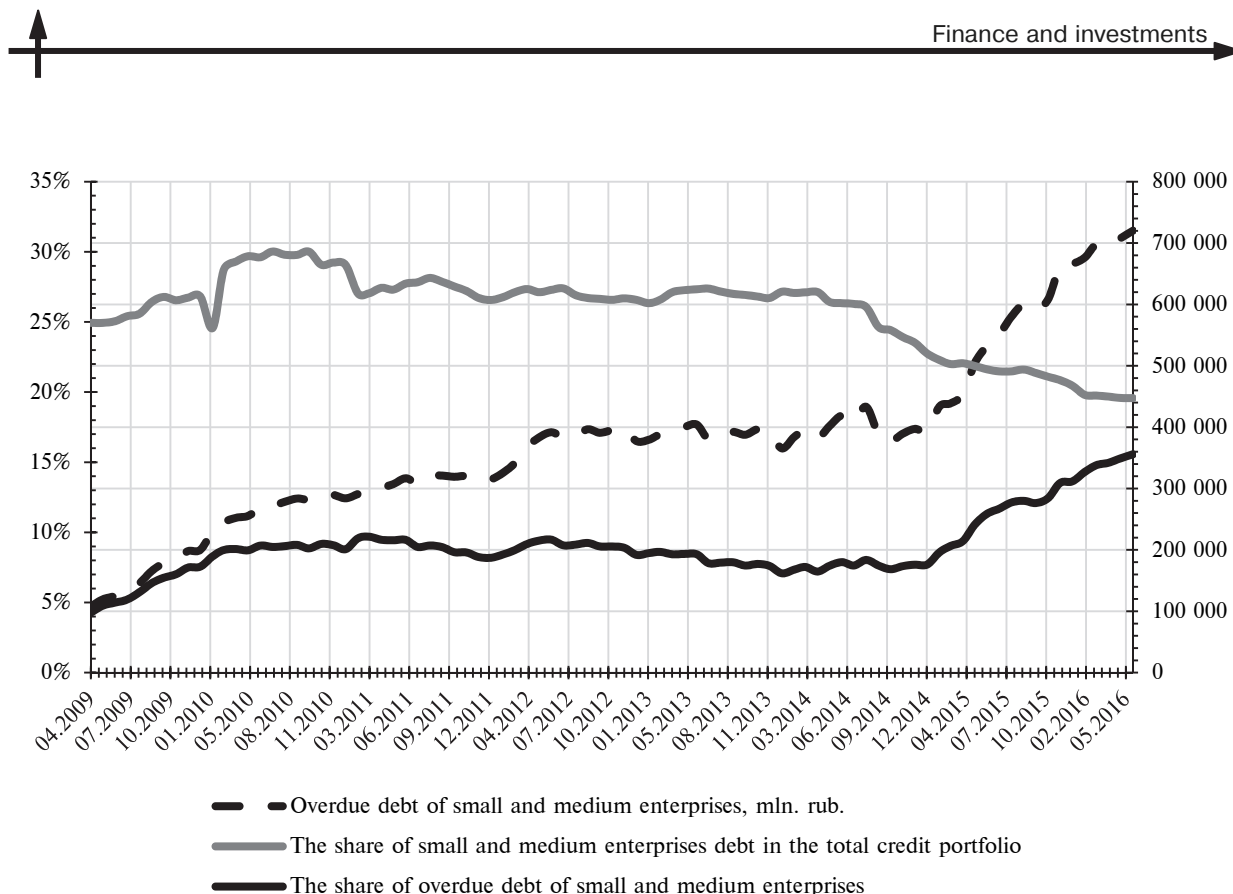
Fig. 2. Data on small and medium enterprises defaulted debt
S o u r c e : Our calculations were based on data of the National Bank of Russia

Methods and results. The simple credit rating procedure, which is regarded as the main stage of the credit process, is not enough for an effective credit policy of banks. Banks should use the complete credit process management system from credit product development to credit monitoring. The credit process is complex and multifaceted and involves a number of stages, each of which is designed to provide an effective credit decision. Each of the stages of the credit process should be viewed as a set of interrelated problems requiring tools (models) for the decision support.

Close integration of the banking information system with statistical software greatly expanded the possibilities to apply the credit-scoring models in practice and successfully use labor-intensive methods for constructing complex mathematical models to classify and monitor the borrowers at different stages of the credit process. For example, study [14] systematized the key groups of methods mentioned in the scientific literature for assessing the credit applications of different categories of borrowers, determining the credit conditions, monitoring the credit liabilities, decision-making at different stages of the credit process, such as statistical methods, neural networks, expert methods, logic and probabilistic methods, methods based on multiset theory, optimization methods, hybrid methods, fuzzy-set descriptions, ensemble modeling.

A decision support system for small business crediting should be developed taking into account the peculiarities of small business in terms of credit risk management. The scientific and practical literature has developed a strong opinion about the specificity of small business crediting in terms of credit application, information and analytical support, a high level of uncertainty associated with many changes in the regulatory and legal information, a desire for tax optimization, a wide range of interpretation of the results of financial ratios analysis, incomplete internal information base for credit risk assessment due to special (simplified) tax systems and other factors.

Chernov and Illarionov identified the following features of small business in Ref. [24]: 'the specificity of historical development of small business in Russia; the versatility of small enterprises; insufficient qualification of personnel which affects a company's performance; deformalization of the economic environment of

small business; high transaction costs associated with credit risk assessment and credit monitoring; lack of adequate security'.

Levchenko [13] described a feature of microenterprises which is that the owners do not share the costs of personal goals and the expenses for maintenance and business development, which is why different approaches to forming the information base for credit risk assessment need to be considered. Information on consumer credits of business owners is essential to assess the credit risk of microenterprises.

Zabolotskaya highlightedthe following issues in [9]: 'the information contained in the financial statements and provided on a certain date may not fully reflect trends in economic activity; financial information requires detailed examination on the reliability due to the generally insufficient level of qualification of entrepreneurs; frequent changes in the regulatory framework reduce the comparability of data for different periods. A high level of uncertainty also creates a low degree of formalization of economic activity that is often associated with the absence of a professional accountant and automation of accounting in companies, which leads to unintentional distortion of accounting and financial reporting'.

Biryukov also noted in Ref. [1] the high level of uncertainty and did not rule out the possibility of complete distortion of the true economic and financial situation of the company in all financial documentation. 'Most small businesses have a limited internal information base because of the application of the simplified taxation system or the unified tax on imputed income. This fact justifies the necessity to use both the official statements (declarations) and managerial reporting'.

Lukashevich claims in [14] that corporate crediting is accompanied by a significant document flow at all stages of the credit process due to the desire of banks to obtain as much information as possible for decision-making. The collected information is measured in different scales (qualitative and quantitative), contains a set of frequently contradictory parameters. A large number of input data has no clear boundaries, emerges from different internal and external sources and complicates the problem of credit risks assessment. The data obtained on the basis of experience, intuition and knowledge of credit analysts who can take into account important individual characteristics of borrowers play an important role for successful credit decisions. From this perspective, the problem of formalizing the acquired knowledge, their replication between other credit managers becomes more and more important. Based on the analysis of the scientific and practical literature concerning credit-scoring models, Lukashevich repeatedly stresses in [14, 15] that applying statistical models to corporate crediting is problematic. This limitation, on the one hand, is due to the stringent requirements for a sample, which determine the possibility of applying statistical methods and the availability of adequate models; on the other hand, different corporate forms, tax regimes, industrial specificity, a significant number of credit products for small businesses and other factors do not allow credit analysts to form a sample that meets all these requirements and is suitable for modeling.

Chernov and Illarionov [24] take the same position with respect to the limited application of statistical methods in credit risk assessment, arguing that the important factor is that the credit analysis process should be based on forming expert judgement. In this regard, applying fuzzy-set descriptions and fuzzy models allows working correctly with the originally qualitative or fuzzy evaluation data.

Exploring the problems of credit risk assessment of small businesses, Kemaeva et al. [10] and Krakovich [12] revealed that each industrial sector of small business is characterized by its balance sheet structure, the main items of expenses and income, normative or recommended values of financial ratios. Small business is characterized by using the simplest approaches to accounting, therefore, analyzing only the official accounting records does not allow obtaining reliable estimates of the financial standing of the borrower.

A considerable number of foreign methods for credit risk assessment are being actively integrated into Russian information andanalytical banking systems; to successfully implement these methods, it is necessary to take into account the peculiarities of the taxation system, the accounting system compared to international standards, the incompleteness and uncertainty of the significant part of the financial information

Thus, Lukashevich et al. presented in [15] the results on applicability of the traditional credit-scoring models including those developed based on foreign data and approaches, which provided a sufficient data variation proving the necessity of taking into account the Russian economic particularities.

Demeshev and Tikhonov [6] compared approaches to modelling the critical financial situation of medium-sized and small Russian private companies in different industries by using financial and non-financial indicators. In general, nonlinear algorithms yielded the best results. An important conclusion is the strong influence of some non-financial indicators such as the industrial sector, the federal district and the age of the enterprise upon the financial conditions. Profitability, leverage and liquidity were found to be the most significat financial ratios.

Bolshakova et al. discussed in [2] the problem of using traditional models based on ratio analysis for estimating the probability of default for Russian small and medium-sized enterprises. The authors concluded that using a single model for monitoring bankruptcy at different time horizons was not justified. For a year or two before the potential default, the key factors for a company to be declared bankrupt are the return on assets, the structure of current assets, the retained earnings as the main source of own funds and the ratio between revenue and variable costs.

The weak predictive ability of the traditional models based on financial ratios analysis to assess credit risks of small businesses remains a key focus for researchers. The main problem in this aspect is connected with selecting financial ratios, the second problem relates to the lack of recommended (normative) values of financial ratios for different industries, which complicates making the credit decision as credit analysts are unable to estimate the extent to which the calculated ratios are acceptable. This confirms the high level of uncertainty in making credit decisions. For example, the authors of [23] proposed a method for applying cluster analysis to identify the normative (recommended) values of financial ratios for companies with different levels of probability of default and offered a method for determining the values of financial ratios recommended or adequate to the current financial condition.

Having systematized the features of small business crediting, it is necessary to formulate the key requirements for the decision support system and suggest a set of typical tasks, solving which will ensure system functionality.

Firstly, taking into account the review of the literature, it is possible to assess the well-established traditional set of quantitative and qualitative factors of small business creditworthiness including financial indicators [1, 6, 10, 11, 16, 24−31]; credit history; experts estimation; factors reflecting the specificity of the region and efficiency of management in company and other factors which allow a wide range of interpretations of the influence on credit risk and do not have clear boundaries. Industrial particularities can be indirectly taken into account through the evaluation of financial ratios, the recommended (normative) values of which are totally different for each industry. In such circumstances, it is necessary to introduce approaches which could take into account the possibility of operating with multi-type quantitative and qualitative data, measured in different scales into the decision support system; formalization of knowledge and expert estimation. Many authors note that neuromathematics methods, fractal techniques and fuzzy logic methods [14, 24] are effective modern tools under highly volatile parameters of the external economic environment . Partial implementation of these aspects may be done as a transition to a common scale of measurement with the same meaning of parameters and application of some techniques based on expert opinions formalization, for example, by using fuzzy-set models, successfully investigated in studies [4, 9, 14, 22, 24, 25].

Secondly, the model laid down in the decision support system should identify the objective and significant patterns between different credit risk factors and minimize the impact of the subjective views of credit analysts for making decisions. As for applying fuzzy-set descriptions, the main drawback of this approach is the subjectivity in the construction of membership functions of fuzzy classifiers. This subjectivity can be partially eliminated by using the obtained credit history. An ensemble of models developed using different expert or statistical approaches can be used for this purpose. The results of the models are aggregated or 'averaged'. Using such a hybrid approach allows adapting decision support system for both expert-oriented credit departments, for example,

when introducing new credit products, and credit departments oriented to processing large volumes of statistic information.

Thirdly, the decision support system should be adaptive, that is, it should be possible to make adjustments to the model, for example, modify the parameters of factors or models, select the approaches to the decision-making process based on different types of input data. The system should not require the involvement of qualified experts for adapting to the new data structure.

Fourthly, the decision support system must allow to interpret the obtained decisions. The high level of ability to explain the credit decision leads to easy interpretation of the results and their visibility.

Fifthly, the decision support system should include only relevant factors (the factors should not be too many and at the same time enough to make proper decisions) and provide the minimum of additional qualification requirements for credit managers and availability of specially developed information and analytical software.

Table systematized the key decisions (tasks) to be made at different stages of the credit process for small businesses and proposed different tools and decision support models described in the scientific literature. Tools and models designed or adapted for Russian small and medium-sized businesses are mostly considered.

Fig. 3 shows the configuration of the major functional subsystems and information flows in the decision support system for small business crediting.

Overview of decision support tools for small businesses at different stages of the credit process

Stage of credit process	Key decisions	Proposed models	Distinctive features
Borrower qualification	1. Assessment of conformity of the borrowers to credit policy 2. The assessment of priority for consideration of the credit application 3. Identification of the information base for risk assessment depending on the category of borrower and purpose of crediting 4. Preliminary risk assessment (pre-scoring) including stop indicators 5. Determination of the method for further risk assessment. 6. Assessment of credit portfolio return 7. Determination of the rational credit portfolio structure	Fuzzy-set model for rapid assessments based on Bellman-Zade principle and the analytic hierarchy process (Lukashevich, [14])	Reduction of the solution of multicriteria tasks to assessment of a complex metric that reflects the confidence in the expert judgements; the ability to take into account the collective opinion of experts and their importance in the assessment; obtaining an estimate of borrower priority.
		Fuzzy model for decision support in crediting (Fironov, [22])	Borrowers are divided into four groups of priority. As the parameters for ranking the following qualitative and quantitative indicators are used: commission; average monthly accounts balances; interest income; borrower loyalty to the bank.
Assessment of credit risk and credit conditions	1. Assessment of credit risk and probability of default. 2. Assessment of credit history 3. Assessment of collateral 4. Assessment of credit conditions 5. Assessment of investment attractiveness of the projects	IRB-oriented discriminant model for estimating the probability of default of small businesses (Efimova, [8])	The model uses traditional financial ratios and generates a probability of default and credit conditions. The model meets the requirements of Basel Capital Accord
		Fuzzy-set risk modeling system for investment and construction projects (Glushchenko and Dolzhenko, [4])	Fuzzy-set model contains 19 input linguistic variables, describing risk factors, and 14 output linguistic variables that characterize the risks of investment and construction projects. The model contains 14 data bases with rules and allows conducting linguistic (qualitative) analysis of the investment project risks.

The rest of the table

Stage of credit process	Key decisions	Proposed models	Distinctive features
		Fuzzy production system (fuzzy inference system) of quantitative and qualitative risk assessment and credit conditions definition (Zabolotskaya andAristarkhov, [9])	Fuzzy production system for modeling credit rating of small business based on fuzzy data bases with 22 qualitative and quantitative indicators. The system allows to replace a set of financial indicators depending on the preferences of the credit expert, the specifics of the company or provided financial documentation. There is no dependence on the sectoral and regional origin. The system suggests the information-analytical database and expert guide (credit analyst) for fuzzification of the proposed indicators. The following groups of indicators are proposed: 1) industry-specific indicators; 2) region-specific indicators; 3) indicators of financial performance.
		Model of enterprises clustering based on neural networks (Biryukov, [1])	The model is considered as a tool to support decision-making on credit risk control. In the proposed concept the factors are linked to a specific sector of the economy and determined by using expert methods with 'additional experts training'. It covers the following groups of indicators: production process indicator; indicator of the financial condition; organizational indicator; the external economic environment indicator.
		Methods of assessing the creditworthiness of small enterprises based on a fuzzy-set mathematical model (Illarionov and Chernov, [24])	The method applies the following indicators: 1) the financial condition: indicators of solvency and liquidity; financial stability; business activity; profitability; 2) qualitative indicators: indicators of regional specificities; qualitative features of the borrowers; 3) industry-specific indicators: perspectives of industry development.
		Model of credit limit calculation, which determines the received individual credit risk of a particular credit application (Levchenko, [13])	Limit calculation is based on the financial and managerial reporting and takes into account the structure of the balance sheet and income statement.
		Methodology of credit rating assessment for small and medium-sized enterprises using fuzzy production system (Karamzin et al., [25])	The financial coefficients are calculated on the basis of the balance sheet and income statement presented in Excel format. The results are processed by fuzzy system by the following 10 fuzzy inference systems: liquidity, financial stability, business activity and profitability; forecasting the overall financial condition; modelling industrial indicators, regional specifics and qualitative characteristics and so on.

<div align="right">The rest of the table</div>

Stage of credit process	Key decisions	Proposed models	Distinctive features
		Guidelines on the assessment of the creditworthiness of small businesses for different industries (Krakovich, [12])	The significance of various sectors for the credit portfolio is determined using statistical methods. The methods of comparative analysis are used to highlight industrial factors influencing on assessment of the creditworthiness of small businesses.
		Methods of aggregation of partial indicators for assessing the creditworthiness of small businesses in the service sector (Demina, [7])	The technique reveals the basic problem of selecting the key factors. The flexible model takes into account the feature of crediting in the service sector.
		Decision support systems for assessing the financial conditions of small and medium-sized enterprises [19]	The basis of the system is the integration of probabilistic and statistical methods of classification analysis (discriminant analysis, logistic regression, classification trees), neural networks in an interactive system using cloud technologies. The system solves the problem of small amount of data, quality of sample and unique samples.
		Mathematical model for credit parameters estimation taking into account the financial condition of small and medium-sized enterprises. (Pylypenko and Hafayan, [16, 17])	According to this technique, the software module has been developed that allows the user to quickly calculate the credit rating and credit conditions based on the individual financial status.
		Method of creating a virtual customer database, which is based on the revealed patterns in financial indicators (Shevchenko andHafayan, [26])	The method gives the linguistic interpretation of the levels of financial performance. There are five clusters of enterprises with different levels of creditworthiness. Database of enterprises can serve as a training sample for classification analysis methods for determining the risk level of real-life business.
		Set of models based on information and statistical approach for estimating the parameters of investment projects (Garanin and Lukashevich, [3])	A discrete-continuous model of investment project life cycle allows experts to obtain not only the probability of transition from one phase of the project to another, but also to determine the duration of the definite investment project stage. The distinctive features of the information and statistical approach to modeling the cash flow is that the possibility of estimating the probability of occurrence of the cash flow is not less than a defined planned value.
		Model of credit rating estimation for innovative companies (Angilella and Mazzщ, [27])	The model focuses on small innovative enterprises. To identify the risk, the following groups of indicators are proposed: technologic risk, market risk, financial position, innovation potential.
		Discriminant model (Z-score) for assessment of default probability (Lazovskaya, [30])	The approach proposes two models: on the basis of only traditional financial ratios and with the addition of non-financial variables (age and size of the company). The accuracy of the classification with a combination of financial and non-financial variables in the control sample amounts to 79%.

Stage of credit process	Key decisions	Proposed models	Distinctive features
Credit monitoring and debt collection	1. Assessment of changes in credit risk 2. Management of credit portfolio 3. Assessment of credit portfolio quality 4. Selection of debt collection strategy 5. Evaluation of prognostic accuracy of credit-scoring models 6. Key performance indicators calculation for assessment of credit department effectiveness	Models developed for the stage of credit risk and credit conditions assessment can be used for on-going monitoring of credit risk. In this case, the models can be used repeatedly to monitor changes in the credit rating value.	
		Guideline for credit monitoring (Ushanov, [21])	Guideline proposes a scheme of credit monitoring process that minimizes the risk of credit default
		Mathematical model for credit portfolio management (Timofeeva and Timofeev, [20])	Forecasting of credit risk and credit portfolio profitability are based on mathematical models of dynamics of credit portfolio structure by using a discrete-time Markov chain. The mathematical formalization of business processes such as organization of credit application approval, debt collection procedure and so on is presented.
		Model for selection of overdue debt collection strategies (Pika, [18])	The technique allows credit analysts to take against the debtor a reasonable decision based on five indicators: the sum of overdue debt; forecasted payments; planned costs for collection; workforce limitation.
		Model of credit portfolio structure optimization (Dem and Parominskaya, [5])	The developed model allows estimating the cumulative risk and credit portfolio return, as well as making credit decision in terms of its effect on the total risk and credit portfolio return. The model also provides the optimal credit portfolio structure.
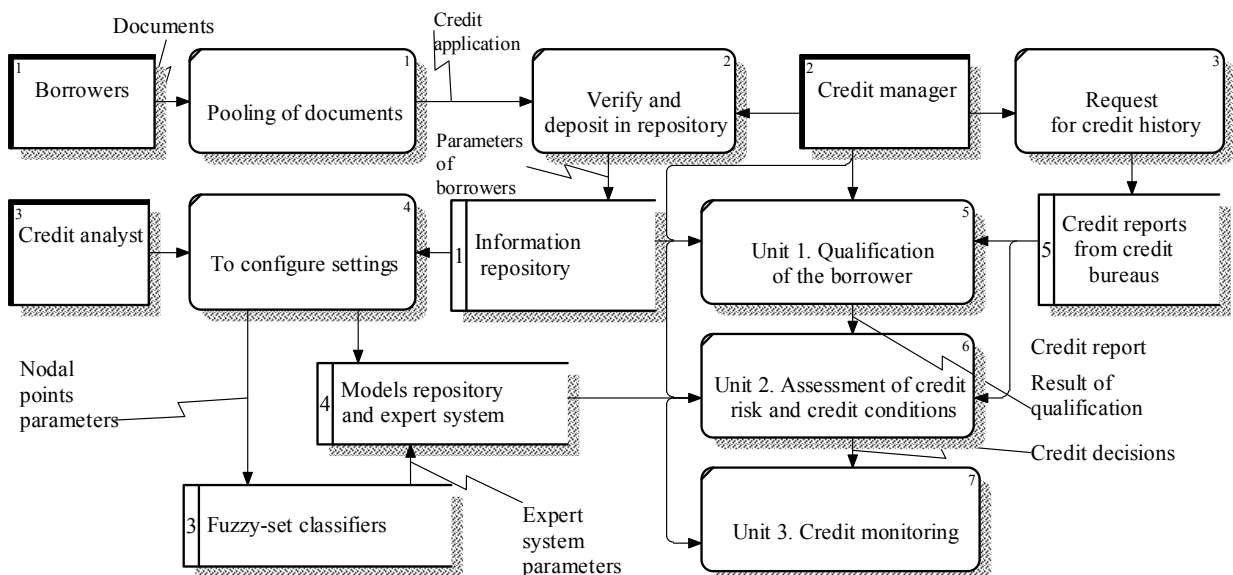
Fig. 3. Functional subsystems and information flows in the credit decision support system
Source: developed by the authors using DFD notation

Conclusions. The study analyzed the specifics of small business crediting. Based on this analysis, the article proposed the requirements for developing a decision support system for making credit decisions, a set of tasks which are advisable to implement as functionality, and a composition of the major functional subsystems defining the structure of decision support system. The distinctive features of the proposed decision support system are as follows: 1) the ability to take into account the specifics of small business crediting including the high level of uncertainty, the use of data in different types of scales for decision-making; 2) support for credit decisions for different types of credit products and categories of borrowers who use different forms of accounting and taxation regimes; 3) the ability to take into account industrial specifics of the borrowers to adjust the model parameters; 4) the ability to customize the parameters of the models with the accumulation of information about the outcome of credit applications and standard (recommended) values of the financial ratios.

For further research it is advisable to develop a standard business process of small business crediting for the proposed credit decision support system and a decision-making algorithm at different stages of the credit process.

REFERENCES

1. **Biryukov A.N.** Metody neyrosetevogo modelirovaniya ranzhirovaniya nalogoplatelshchikov dlya opredeleniya kreditnogo riska. Ekonomicheskiy analiz: teoriya i praktika. 2015. № 12(411). S. 58−66. (rus)

2. **Bolshakova O.Ye., Maksimov A.G., Maksimova N.V.** O modelyakh diagnostiki sostoyatelnosti predpriyatiy malogo i srednego biznesa. *Vestnik VGU. Seriia «Ekonomika i upravleniye».* 2014. № 3. S. 131−142. (rus)

3. **Garanin D.A., Lukashevich N.S.** Modelirovaniye parametrov investitsionnogo proyekta na osnove informatsionno-statisticheskogo podkhoda. *Ekonomicheskiy analiz: teoriya i praktika.* 2014. № 33(384). S. 37−48. (rus)

4. **Glushenko S.A., Dolzhenko A.I.** Sistema nechetkogo modelirovaniya riskov investitsionno-stroitelnykh proyektov. *Biznes-informatika.* 2015. № 1(31). S. 48−58. (rus)

5. **Dem O.D., Parominskaya O.S.** Razrabotka modeli dlya optimizatsii struktury kreditnogo portfelya banka. *Vestnik Vitebskogo gosudarstvennogo tekhnologicheskogo universiteta.* 2015. № 28. S. 186−195. (rus)

6. **Demeshev B.B.,** Tikhonova A.S. Prognozirovaniye bankrotstva rossiyskikh kompaniy: mezhotraslevoye sravneniye. *Ekonomicheskiy zhurnal Vysshey shkoly ekonomiki.* 2014. T. 18. № 3. S. 359−386. (rus)

7. **Demina Ye.N.** Napravleniya formirovaniya kompleksnoy otsenki kreditosposobnosti malogo biznesa v sfere uslug. *RISK: Resursy, informatsiya, snabzheniye, konkurentsiya.* 2011. № 2. S. 254−257. (rus)

8. **Yefimova Yu.V.** Otsenka veroyatnosti defolta zayemshchikov malogo biznesa rossiyskimi bankami s uchetom mezhdunarodnykh trebovaniy. *Finansy i biznes.* 2010. № 2. S. 34−41. (rus)

9. **Zabolotskaya V.V., Aristarkhov A.A.** Metodika otsenki kreditosposobnosti malykh predpriyatiy. *Finansy i kredit.* 2009. № 12(348). S. 61−73. (rus)

10. **Kemayeva S.A., Kozlova Ye.Ye., Ionova Ye.S.** Analiz metodik otsenki kreditosposobnosti malogo biznesa v rossiyskoy i zarubezhnoy praktike. *Ekonomicheskiy analiz: teoriya i praktika.* 2014. № 8. S. 50−61. (rus)

11. **Koneva O.V., Demina Ye.N.** Metody modelirovaniya kreditnogo reytinga predpriyatiy malogo biznesa. *Finansy i kredit.* 2010. № 29(413). S. 37−43. (rus)

12. **Krakovich V.V.** Uchet otraslevykh faktorov v otsenke kreditosposobnosti subyektov malogo biznesa. *Finansovaya analitika: problemy i resheniya.* 2015. № 32. S. 51−60. (rus)

13. **Levchenko Ye.V.** Identifikatsiya informatsionnoy bazy pri limitirovanii kreditovaniya predpriyatiy mikro- i malogo biznesa. *Teoriya i praktika obshchestvennogo razvitiya.* 2014. № 10. S. 144−147. (rus)

14. **Lukashevich N.S.** Otsenka kreditosposobnosti organizatsiy na osnove kompozitsii ekspertnogo i neyrosetevogo podkhodov. *Finansy i kredit.* 2011. № 27. S. 30−39. (rus)

15. **Lukashevich N.S., Garanin D.A., Chachina Ye.G.** Issledovaniye primenimosti modeley prognozirovaniya bankrotstva dlya subyektov malogo predprinimatelstva. *Ekonomika i predprinimatelstvo.* 2015. № 10-1(63-1). C. 904−908.

16. **Pelipenko Ye.Yu., Khalafyan A.A.** Otsenka platezhesposobnosti rossiyskikh predpriyatiy na osnove sovremennykh tekhnologiy statisticheskogo modelirovaniya. *Nauchnyy zhurnal KubGAU.* 2010. № 08(062). S. 374−385. (rus)

17. **Pelipenko Ye.Yu., Khalafyan A.A.** Otsenka finansovogo sostoyaniya predpriyatiya na osnove metoda neyronnykh setey. *Avtomatizatsiya i sovremennyye tekhnologii.* 2013. № 9. S. 40−43. (rus)

18. **Pika A.V.** Metod upravleniya strategiyey vzyskaniya prosrochennoy zadolzhennosti. *Finansy i kredit.* 2012. № 24(504). S. 55-59. (rus)

19. Sistema podderzhki prinyatiya resheniya v sfere otsenki finansovogo sostoyaniya predpriyatiy MSB : sayt laboratorii statisticheskikh issledovaniy Kubanskogo gosudarstvennogo universiteta. URL: http://statlab.kubsu.ru/sites/project_bank/project.php (data obrashcheniya: 10.08.2016). (rus)

20. **Timofeyev N.A., Timofeyeva G.A.** Prognozirovaniye sostavlyayushchikh kreditnogo portfelya na osnove modeli Markovskoy tsepi. *Avtomatika i telemekhanika.* 2012. № 4. S. 47−65. (rus)

21. **Ushanov A.Ye.** Optimizatsiya kreditnogo protsessa v usloviyakh vyzovov. *Finansy i kredit.* 2015. № 21. S. 37−43. (rus)

22. **Fironov A.N.** Fuzzy-modelirovaniye prinyatiya resheniy v bankovskoy praktike. *Bankovskiye tekhnologii.* 2006. № 2. S. 34−40. (rus)

23. **Chachina Ye.G., Lukashevich N.S., Keyserukhskaya U.K.** Otsenka rekomenduyemykh znacheniy finansovykh koeffitsiyentov s ispolzovaniyem iyerarkhicheskogo klasternogo analiza. *Ekonomika i predprinimatelstvo.* 2012. № 4(27). S. 205−209. (rus)

24. **Chernov V.G., Illarionov A.V.** Metodika otsenki kreditosposobnosti predpriyatiy sfery malogo biznesa, osnovannaya na nechetkomnozhestvennoy matematicheskoy modeli. *Finansy i kredit.* 2006. № 20. S. 72−78. (rus)

25. **Shevchenko I.V., Karmazin V.N., Kovalenko A.V.** Kompleksnaya otsenka kreditosposobnosti predpriyatiy malogo i srednego biznesa s pomoshchyu nechetkoy produktsionnoy sistemy. *Finansovaya analitika: problemy i resheniya.* 2008. № 2. S. 81−86. (rus)

26. **Shevchenko I.V., Khalafyan A.A., Pelipenko Ye.Yu.** Sozdaniye virtualnoy kliyentskoy bazy dlya analiza kreditosposobnosti rossiyskikh predpriyatiy. *Finansy i kredit.* 2010. № 1. S. 13−18. (rus)

27. **Angilella S., Mazzù S.** The financing of innovative SMEs: A multicriteria credit rating model. *European Journal of Operational Research*, 2015, no. 244, pp. 540−554. URL: http://dx.doi.org/10.1016/j. ejor.2015.01.033

28. **Glennon D., Nigro P.** Measuring the default risk of small business loans: a survival analysis approach. *Journal of money, credit, and banking*, 2005, vol. 37, no. 5, pp. 923−947.

29. **Lin S.-M., Ansell J., Andreeva G.** Predicting default of a small business using different definitions of financial distress. *Journal of operational research society*, 2011, no. 4, pp. 539−548.

30. **Lugovskaya L.** Predicting default of Russian SMEs on the basis of financial and non-financial variables. *Journal of financial services marketing*, 2009, vol. 14, pp. 301−313.

31. **Pederzoli C., Thoma G., Torricelli C.** Modelling credit risk for innovative SMEs: the role of innovation measures. *Journal of financial services research*, 2013, vol. 44.

СПИСОК ЛИТЕРАТУРЫ

1. **Бирюков А.Н.** Методы нейросетевого моделирования ранжирования налогоплательщиков для определения кредитного риска // Экономический анализ: теория и практика. 2015. № 12(411). С. 58−66.

2. **Большакова О.Е., Максимов А.Г., Максимова Н.В.** О моделях диагностики состоятельности предприятий малого и среднего бизнеса // Вестник ВГУ. Серия «Экономика и управление». 2014. № 3. С. 131−142.

3. **Гаранин Д.А., Лукашевич Н.С.** Моделирование параметров инвестиционного проекта на основе информационно-статистического подхода // Экономический анализ: теория и практика. 2014. № 33(384). С. 37−48.

4. **Глушенко С.А., Долженко А.И.** Система нечеткого моделирования рисков инвестиционно-строительных проектов // Бизнес-информатика. 2015. № 1(31). С. 48−58.

5. **Дём О.Д., Пароминская О.С.** Разработка модели для оптимизации структуры кредитного портфеля банка // Вестник Витебского государственного технологического университета. 2015. № 28. С. 186−195

6. **Демешев Б.Б., Тихонова А.С.** Прогнозирование банкротства российских компаний: межотраслевое сравнение // Экономический журнал Высшей школы экономики. 2014. Т. 18. № 3. С. 359−386.

7. **Демина Е.Н.** Направления формирования комплексной оценки кредитоспособности малого бизнеса в сфере услуг // РИСК: Ресурсы, информация, снабжение, конкуренция. 2011. № 2. С. 254−257.

8. **Ефимова Ю.В.** Оценка вероятности дефолта заемщиков малого бизнеса российскими банками с учетом международных требований // Финансы и бизнес. 2010. № 2. С. 34-41.

9. **Заболоцкая В.В., Аристархов А.А.** Методика оценки кредитоспособности малых предприятий // Финансы и кредит. 2009. № 12(348). С. 61−73.

10. **Кемаева С.А., Козлова Е.Е., Ионова Е.С.** Анализ методик оценки кредитоспособности малого бизнеса в российской и зарубежной практике // Экономический анализ: теория и практика. 2014. № 8. С. 50−61.

11. **Конева О.В., Демина Е.Н.** Методы моделирования кредитного рейтинга предприятий малого бизнеса // Финансы и кредит. 2010. № 29(413). С. 37−43.

12. **Кракович В.В.** Учет отраслевых факторов в оценке кредитоспособности субъектов малого бизнеса // Финансовая аналитика: проблемы и решения. 2015. № 32. С. 51−60.

13. **Левченко Е.В.** Идентификация информационной базы при лимитировании кредитования

предприятий микро- и малого бизнеса // Теория и практика общественного развития. 2014. № 10. С. 144—147.

14. **Лукашевич Н.С.** Оценка кредитоспособности организаций на основе композиции экспертного и нейросетевого подходов // Финансы и кредит. 2011. № 27. С. 30—39.

15. **Лукашевич Н.С., Гаранин Д.А., Чачина Е.Г.** Исследование применимости моделей прогнозирования банкротства для субъектов малого предпринимательства // Экономика и предпринимательство. 2015. № 10-1(63-1). С. 904—908.

16. **Пелипенко Е.Ю., Халафян А.А.** Оценка платежеспособности российских предприятий на основе современных технологий статистического моделирования // Научный журнал КубГАУ. 2010. № 08(062). С. 374—385.

17. **Пелипенко Е.Ю., Халафян А.А.** Оценка финансового состояния предприятия на основе метода нейронных сетей // Автоматизация и современные технологии. 2013. № 9. С. 40—43.

18. **Пика А.В.** Метод управления стратегией взыскания просроченной задолженности // Финансы и кредит. 2012. № 24(504). С. 55—59.

19. Система поддержки принятия решения в сфере оценки финансового состояния предприятий МСБ : сайт лаборатории статистических исследований Кубанского государственного университета. URL: http://statlab.kubsu.ru/sites/project_bank/project.php (дата обращения: 10.08.2016).

20. **Тимофеев Н.А., Тимофеева Г.А.** Прогнозирование составляющих кредитного портфеля на основе модели Марковской цепи // Автоматика и телемеханика. 2012. № 4. С. 47—65

21. **Ушанов А.Е.** Оптимизация кредитного процесса в условиях вызовов // Финансы и кредит. 2015. № 21. С. 37—43.

22. **Фиронов А.Н.** Fuzzy-моделирование принятия решений в банковской практике // Банковские технологии. 2006. № 2. С. 34-40.

23. **Чачина Е.Г., Лукашевич Н.С., Кейсерухская У.К.** Оценка рекомендуемых значений финансовых коэффициентов с использованием иерархического кластерного анализа // Экономика и предпринимательство. 2012. № 4(27). С. 205—209.

24. **Чернов В.Г., Илларионов А.В.** Методика оценки кредитоспособности предприятий сферы малого бизнеса, основанная на нечеткомножественной математической модели // Финансы и кредит. 2006. № 20. С. 72-78.

25. **Шевченко И.В., Кармазин В.Н., Коваленко А.В.** Комплексная оценка кредитоспособности предприятий малого и среднего бизнеса с помощью нечеткой продукционной системы // Финансовая аналитика: проблемы и решения. 2008. № 2. С. 81—86.

26. **Шевченко И.В., Халафян А.А., Пелипенко Е.Ю.** Создание виртуальной клиентской базы для анализа кредитоспособности российских предприятий // Финансы и кредит. 2010. № 1. С. 13—18.

27. **Angilella S., Mazzù S.** The financing of innovative SMEs: A multicriteria credit rating model // European Journal of Operational Research, 2015, no. 244, pp. 540—554. URL: http://dx.doi.org/10.1016/j.ejor.2015.01.033

28. **Glennon D., Nigro P.** Measuring the default risk of small business loans: a survival analysis approach // Journal of money, credit, and banking, 2005, vol. 37, no. 5, pp. 923—947.

29. **Lin S.-M., Ansell J., Andreeva G.** Predicting default of a small business using different definitions of financial distress // Journal of operational research society, 2011, no. 4, pp. 539—548.

30. **Lugovskaya L.** Predicting default of Russian SMEs on the basis of financial and non-financial variables // Journal of financial services marketing, 2009, vol. 14, pp. 301—313.

31. **Pederzoli C., Thoma G., Torricelli C.** Modelling credit risk for innovative SMEs: the role of innovation measures // Journal of financial services research, 2013, vol. 44.

LUKASHEVICH Nikita S. — Peter the Great St. Petersburg Polytechnic University.
195251. Politechnicheskaya str. 29. St. Petersburg. Russia. E-mail: lukashevich@kafedrapik.ru

ЛУКАШЕВИЧ Никита Сергеевич — доцент Санкт-Петербургского политехнического университета Петра Великого, кандидат экономических наук.
195251, ул. Политехническая, д. 29, Санкт-Петербург, Россия. E-mail: lukashevich@kafedrapik.ru

GARANIN Dmitrii A. — Peter the Great St. Petersburg Polytechnic University.
195251. Politechnicheskaya str. 29. St. Petersburg. Russia. E-mail: garanin@kafedrapik.ru

ГАРАНИН Дмитрий Анатольевич — доцент Санкт-Петербургского политехнического университета Петра Великого, кандидат экономических наук.
195251, ул. Политехническая, д. 29, Санкт-Петербург, Россия. E-mail: garanin@kafedrapik.ru

S.N. Yashin, Yu.V. Trifonov, E.V. Koshelev

THE PRICE OF MOTIVATING CORPORATE TOP MANAGERS USING WARRANTS

С.Н. Яшин, Ю.В. Трифонов, Е.В. Кошелев

ЦЕНА МОТИВАЦИИ ТОП-МЕНЕДЖЕРОВ КОРПОРАЦИИ С ПОМОЩЬЮ ВАРРАНТОВ

In today's economic environment, an important characteristic of top-echelon executives includes not only their qualification and business reputation but also their motivation for the company development. The majority of present-day investigators have come to a general consensus thatthe performance of the top management in a company must be objectively evaluated by the market, rather than by the subjective human factor (i.e., by the top managers themselves). While using warrants to evaluate the motivation of the top-managers is undoubtedly appealing, it is evident that this motivation, as any other, must have a certain value for the company, and needs to be pre-evaluated. Even though the due date for new warrants will occur in the far future, the market is even now revaluating corporate securities on the basis of future opportunities. The common-stock value is adjusted with allowance for anticipated dilution that results from exercising warrants. The Black—Scholes model is used in most cases in order to evaluate European options, since it provides a conservative, i.e., the lowest, option value. However, a model with dividends for a European-type warrant should be used for more realistic corporate business presentation. In such a case, the warrant and stock values can be theoretically adjusted until the warrant value has become equal to zero. The stock value, however, will significantly decrease as compared to the original market value. But in actual practice, markets ineffectually respond to issuing warrants by companies; therefore, the stock value declines in a minor way. We then recommend to decide upon the adjustment of the fair stock price which would be following the first specification of the fair warrant price. In this case, the price of motivating top managers using warrants is calculated through multiplying the magnitude of reduction in the stock value by the number of company shares in circulation.

TOP MANAGEMENT MOTIVATION; WARRANTS; BLACK-SCHOLES MODEL; BLACK—SCHOLES MODEL WITH DIVIDENDS.

В современных экономических условиях важной характеристикой управленческого персонала высшего звена являются не только его квалификация и деловая репутация, но также и мотивация на развитие компании. Большинство современных исследователей пришли к общему мнению, согласно которому для объективной оценки деятельности топ-менеджмента компании необходимо, чтобы результаты их работы оценивал рынок, а не субъективный человеческий фактор (в лице тех же топ-менеджеров). При всей привлекательности оценки мотивации топ-менеджеров с помощью варрантов очевидно, что данная мотивация, как и любая другая, должна иметь определенную значимость для компании, которую необходимо предварительно оценить. Несмотря на то, что срок исполнения новых варрантов наступит в отдаленном будущем, рынок уже сейчас переоценивает акции компании, исходя из будущих возможностей. Цена акций корректируется с поправкой на ожидаемое разбавление, которое является следствием исполнения варрантов. Для оценки европейских опционов чаще всего используется модель Блэка—Шоулза, так как она дает консервативную, т. е. наиболее низкую, стоимость опциона. Однако для более реалистичной картины деятельности корпорации следует использовать модель с дивидендами для варранта европейского типа. При этом процесс корректировки стоимостей варранта и акции теоретически можно проводить до тех пор, пока стоимость варранта не станет равной нулю. Стоимость акции при этом уменьшится существенно, по сравнению с первоначальным рыночным значением. Однако на практике рынки слабо реагируют на выпуск варрантов компаниями, таким образом, стоимость акций снижается незначительно. Мы рекомендуем остановиться на той корректировке справедливой цены акции, которая будет наблюдаться после первого уточнения справедливой цены варранта. Цена мотивации топ-менеджеров с помощью варрантов в этом случае вычисляется путем умножения величины снижения стоимости акции на количество акций компании в обращении.

МОТИВАЦИЯ ТОП-МЕНЕДЖЕРОВ; ВАРРАНТЫ; МОДЕЛЬ БЛЭКА—ШОУЛЗА; МОДЕЛЬ БЛЭКА—ШОУЛЗА С ДИВИДЕНДАМИ.

1. Introduction. Under current dynamic conditions of the capital market development in Russia, the company management efficiency becomes more and more relevant. Company owners cannot take fully qualified managerial decisions, which is why they employ top

managers for whom company management is a profession [1]. Against this background, not only qualification of top-echelon managerial personnel but also its reputation and motivation for the company growth and development are important factors [2]. Conventional compensation packages of a modern corporate top manager used for motivation may comprise the following [3]:

− a salary;
− a bonus conditioned on the company's profitability;
− an initiative part based on price appreciation;
− a right to use corporate assets;
− a social package.

However, this material remuneration system for managers has the following major deficiencies [3]:

− a tenuous relationship between remuneration and real accomplishments;
− an inadequate level and a high disparity between salaries of top managers and employees;
− manipulability of company reporting.

The problem of effectively motivating corporate top managers is the subject of wide speculation in the financial literature. Managers are often more interested in their own well-being than in company prosperity. There arises a conflict of interest, which leads to shareholders incurring agency costs [4, 5].

2. Task Description. There is a number of methods and recommendations for motivating top managers more efficiently. For example, in his book [4], Limitovsky showed how the size of a top manager's material remuneration could be correlated to the eventual result of the company's activities under the leadership of such an agent. For that end, it is advised to use not earnings, since they may be manipulated using both accounting and non-accounting techniques, but economic value added (EVA) that is created by new investment or innovative projects of the company. But in this case, if projects are short-term or medium-term, maximizing the EVA may not result in maximizing the net present value (NPV) of the project [4].

In order to solve the top management motivation discrepancy problem using the EVA method, a number of authors [6, 7] propose to use a modified EVA indicator, i.e. EVA(m). This makes it possible to encourage top managers only based on the results of already accomplished projects or their significant stages.

However, it is important to motivate top managers not only financially but also non-financially. Thus, book [8] obtained results representing a practical utility for reference motivational preferences of top managers. For any innovative project, it is possible to define an optimal value of NPV, relying on which it is fine to organize an efficient motivation system for the top manager who, in this case, becomes a «friend» to the company. If this approach is ignored, the top manager may turn into a «diversionist» or simply fail to find a common language with the company owners and drop out of the project. In this regard, it was established that the equilibrium value of NPV was in direct relationship to the premium fund available in the company. This imposes restrictions on the company motivation capabilities, which is also to be considered.

As can be seen from the above, a more profound look at the issue of effective motivation of corporate top management implies subdividing these agents into corporate friends, regents (absorbing the company capital to the greatest extent possible without any commitment to results) and diversionists (taking decisions to the detriment of other shareholders and the business in general). At the same time, Limitovsky [2] proposes to regard top managers as two types of insiders in a company: insiders adding value to the company and insiders motivated to increase the company's value. In this regard, in practice, an insider's share in the profits is determined according to Limitovsky's model [2]; this share outweighs the loss of alternative profits (diversionist) and at the same time creates no destructive motivation (regent). Consequently, paper [2] proves an important practical conclusion consisting in the fact that a rational insider bearing no pecuniary responsibility for accepting inefficient projects cannot be motivated in a constructive way.

However, many authors believe that for a really objective evaluation of managers, it is required that their work be evaluated by the market, rather than by the managers themselves [4, 9, 10]. Then, alternate ways to resolve the top management motivation conflicts using the EVA or EVA(m) method may include the following [4].

1. Transferring a portion of the company shares to such managers. In this case, however, the managers become the key dangerous persons in the joint-stock company.

2. Indexing the managers' fees according to the company's stock value. However, transferring, for instance, stock call options to them in that case is dangerous as the managers may become the company's co-owners. That is why it is better

to use non-deliverable options providing for no delivery of any underlying asset. In addition, options must be European and confined to the project completion time. This is required in order to prevent the managers from any action aimed at a short-term rise in the market stock price.

3. Research Technique. Motivating top managers by means of call options on shares in the company managed by them is fairly popular in the practice of the financial and academic community. Thus, Brigham and Houston [11] write that the manager remuneration system must be arranged in such a way that managers should receive fees according to a stock value in a long-run period, rather than at the time of exercising a share option. This means that share options should be transferred step by step, over a period of several years, so that managers would be interested in maintaining a high stock value all this while.

However, stock call options issued to top managers are essentially different from conventional stock options. They are usually called warrants. In this context, let us consider in detail what a warrant is by definition.

Brigham and Gapensky [12] write that a warrant is an option issued by a company, which entitles its holder to purchase a preset number of shares in the company at a determined price. Warrants are often distributed when placing a loan and are used to induce investors to buy long-term bonds of a company having a lower interest rate than under other purchase conditions.

Marshall and Bansal [13] assert that warrants differ from stock options by several positions. First, warrants are issued by the company whose shares are indeed an asset forming the basis of a warrant. Second, warrants not necessarily cover 100 shares. Third, they have a very extensive validity period, usually from three to ten years. Fourth, they do not have to be exercised throughout the validity period; the exercise period may be more limited. Fifth, they are often issued together with other corporate securities «attached» to them — in most cases, debt securities and preferred shares, but warrants are detachable. Namely, if debt securities or shares have been purchased together with warrants, then the warrants can be «detached» and sold separately from such debt securities or stockholders' equity. Warrants are also used as an incentive for key employees to motivate them to work to the best advantage of shareholders (to reduce agency costs).

Kuznetsov [14] further specifies additional properties of warrants. Unlike call options, warrants are issued in limited quantities. The total quantity of warrants of a certain type decreases in course of time as they are exercised. Exercising warrants results in their gradual reduction, while exercising call options has no impact on the issuing entity's position. Warrants are usually issued for extended lengths of time (for 5 years and longer). Perpetual warrants are issued as well.

In this connection, Hall [9] differentiates such concepts as a «warrant» and a «managerial stock option». In particular, he defines a warrant as a call option that is often associated with issue of bonds. A warrant is issued in addition to bonds in order to make them more attractive to investors. Generally, warrants remain in force for many years. They are sometimes listed separately from bonds, to which they were originally attached. Hall defines a managerial stock option as a call option issued to incentivize corporate managers.

Nevertheless, Damodaran [15] defines a warrant in a simpler way, namely as a call option issued by a company either to perform a contract providing for the management remuneration or to raise the stockholders' equity. We will rely on this definition below.

While motivating top managers through using warrants is fairly attractive, it stands to reason that this motivation, as any other, must have a certain value for a company. Recall that it is impractical to issue American warrants to managers. They should be European. However, while the due date for new warrants will occur in the far future, the market will even now revaluate corporate securities on the basis of these future opportunities. A potential warrant exercise will increase the number of circulating corporate securities and infuse new blood into the company. At the same time, both these factors have an effect on the stock price. The anticipated negative effect (due to «dilution») of the warrant exercise will debase other warrants that are similar to call options. The stock price is also adjusted with allowance for the anticipated dilution that results from the option exercise [15].

Damodaran uses the Black–Scholes model without dividends in his book [15] to valuate a warrant. However, for more realistic corporate business presentation, a model with dividends for a European-type warrant should be used. For example, Krushvits, Shefer and Shvake [17] suggest using a binomial CRR model [18] with dividends. But this model is a single-period model, and dividends are paid out only once at the end of the scheduled period.

Burenin describes both a binomial multi-period share option pricing model with permanent dividends and the Black—Scholes model with permanent dividends in his book [19]. The latter model is also used by such authors as Hall [9] and Damodaran [15]. Even though the above-mentioned authors use these models for conventional equity options, their application for warrants has some computational peculiarities that we are going to analyze below. It should be also noted that the Black—Scholes model is more often used to valuate European options since it provides a lowest, i.e., conservative, option value [4]. Therefore, to estimate the value of a European warrant, we are going to use the Black—Scholes model with permanent dividends. Then let us describe the proposed model for calculating a top management motivation price using warrants.

4. Model Setup. The adjustment for dilution affecting the stock price is simple enough in the Black—Scholes model. The stock price is adjusted with allowance for the anticipated dilution that results from exercising the option. For warrants, for instance [15]:

$$S_k = \frac{S_{k-1} n_S + W_{k-1} n_W}{n_S + n_W},$$

where S is the current share value (RUB), n_S is the number of shares in circulation (pcs), W is the value of a warrant in circulation (RUB), n_W is the number of warrants in circulation (pcs), k is the iteration number.

When exercising warrants, the number of circulating shares will increase, which will result in a reduction in the share price. The numerator of the formula shows the stockholders' equity market value, including shares and warrants in circulation. The reduction S will lower the call option value [15].

The longer the option life is, the less practical is the estimated present value of dividends, so an alternative approach can be used. If throughout the option life a permanence of dividend yield is expected (y = dividends/current asset value), then the Black—Scholes model can be modified in the following way [9, 15, 19]:

$$W = Se^{-yt} N(d_1) - Ke^{-rt} N(d_2);$$

$$d_1 = \frac{\log \frac{S}{K} + \left(r - y + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}};$$

$$d_2 = d_1 - \sigma\sqrt{t},$$

where t is the time to the option exercise (years); $N(d)$ is the cumulative normal distribution function; K is the strike price (RUB); r is the continuous yearly rate of risk-free return (growth power) (%); σ is the mean-square deviation of the annual price/earnings ratio (%).

In such an analysis, there is something like an endless circle since for the estimated adjustment for dilution S, it is required to know the warrant value W, and for valuation of the warrant, it is required to have the adjustment for dilution S. This problem can be solved by starting the calculation process with an assumption in terms of the warrant value W_0 (for example, the current market value of the warrant). This will give us the required value S_1, and the obtained value can be used as an input parameter for revaluation of the warrant value W_1 [15].

5. Empirical Results. As an illustration of the model, let us consider the following example [15]. *Avatek Corporation* is a company dealing with real property. It has 19.637 million circulating shares selling at the price of 0.38 US dollars per share. At the present time, the company has issued for top managers 1.8 million European warrants whose due date expires in 4 years, and whose strike price is 2.25 US dollars. The mean-square deviation of the price/earnings ratio was 93%. The four-year continuous rate for treasury bonds is equal to 4.9% per annum. The warrants were on sale at the price of 0.12 US dollars per warrant at the time of this analysis. We will also add the condition that the continuous dividend yield will remain unchanged in the next 4 years and will be 2.51 % per annum. It is required to estimate the adjusted share price and warrant value as well as the top management motivation price through the use of the warrants.

Applying the model described by us, we have the following input parameters of the model:
S_0 = 0.38 US dollars,
N_S = 19.637 million shares,
W_0 = 0.12 US dollars,
n_W = 1.8 million warrants,
y = 2.51 %, t = 4 years,
K = 2.25 US dollars,
r = 4.9 %, σ = 0.93.
Then

$$S_1 = \frac{S_0 n_S + W_0 n_W}{n_S + n_W} = \frac{0.38 \cdot 19.637 + 0.12 \cdot 1.8}{19.637 + 1.8} =$$
$$= 0.358169 \text{ (US dollars)}.$$

This adjustment for the dilution of the share price allows to revaluate the fair market value of the warrant W_1:

$$d_1 = \frac{\log\dfrac{0.358169}{2.25} + \left(0.049 - 0.0251 + \dfrac{0.93^2}{2}\right)4}{0.93 \cdot 2} =$$

$$= -0.006602;$$

$$d_2 = -0.006602 - 0.93 \cdot 2 = -1.866602;$$

$$N(d_1) = 0.5 - 0.002641 = 0.497359;$$

$$N(d_2) = 0.5 - 0.469062 = 0.030938;$$

$$W_1 = 0.358169 e^{-0.0251 \cdot 4} \cdot 0.497359 - 2.25 e^{-0.049 \cdot 4} \times$$

$$\times 0.030938 = 0.103901 \text{ (US dollars)}.$$

Please note that the obtained values d_1 and d_2 do not match the exact tabular values of the cumulative normal distribution function $N(d)$ [4, 12]. That is why, to obtain the exact values, we used the method of proportional parts [5, 17, 20].

However, our 1st iteration of the values S and W necessitates their further specification. Repeating the above procedure, we obtain the following values S and W in Tab. 1.

In order to visualize the obtained data, let us construct graphs of the values S and W according to the iteration number (Fig. 1, 2) using the *Matlab* package for that end [21, 22].

As is clear from the graphs, the values S and W can be theoretically adjusted until the warrant value W has become equal to zero. The stock value S, however, will significantly decrease as compared to the original value $S_0 = 0.38$ US dollars. But in actual practice, markets ineffectually respond to issuing warrants by companies; therefore, the stock value declines in a minor way. That is why recommend to decide upon an adjustment of the fair stock price which would be following the first specification of the fair warrant price. In such a manner, the new market price per share will be approximately $S_2 = 0.336819$ US dollars, and the new market price per warrant will be $W_1 = 0.103901$ US dollars. Considering the fact that *Avatek Corporation* has 19.637 million shares in circulation at the present moment, the top management motivation price estimated through the use of warrants will be approximately $(0.38 - 0.336819)$ 19.637 = 0.847945 million US dollars.

Table 1

Results of Five Iterations of the Share Fair Market Value S and the Warrant Value W (US dollars)

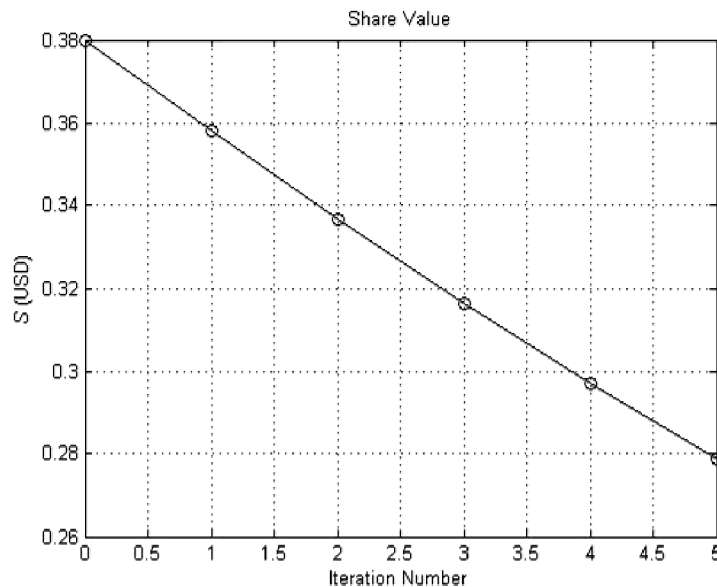|	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Share value S	0.358169	0.336819	0.316461	0.297072	0.27863
Warrant value W	0.103901	0.094364	0.085551	0.077439	−

Fig. 1. Share Fair Market Values S According to Iteration Number (US dollars)
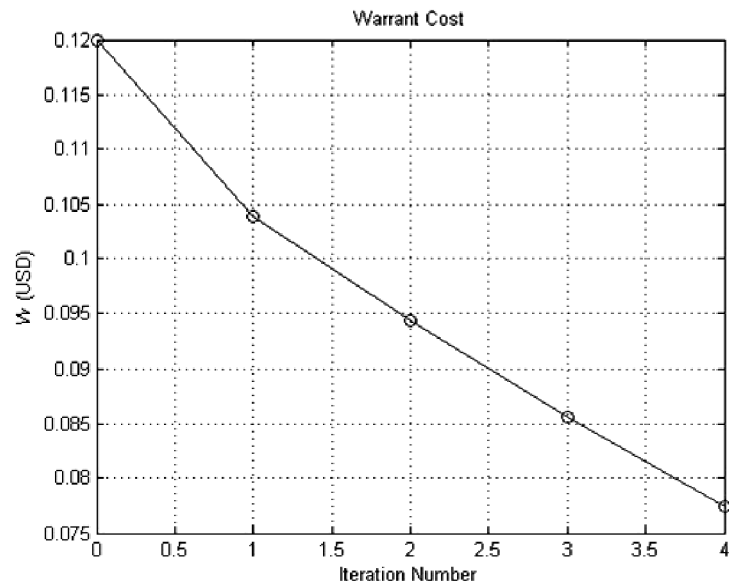
Fig. 2. Warrant Fair Market Values *W* According to Iteration Number (US dollars)

6. Discussion. This outcome should be compared with the closest equivalent. It would be improvident to consider the obtained motivation price as an absolute indicator that decreases or increases opportunities for the company to invest in new promising projects. Even though the budget of the company's investment fund is highly restricted, this amount of 0.847945 million US dollars is not related directly to the current budget of the company. This indicator is, on the contrary, market-oriented to a greater extent and by no means requires any incentive payment for the work of top managers in such an amount. Quite the opposite, it reflects a current estimate of their performance in accordance with their skill, reputation and motivation level.

We are of the opinion that it makes most sense to compare the amount of 0.847945 million US dollars with the current value of the company's market value growth for the planned period of 4 years. If it is expected that the current growth value exceeds 0.847945 million US dollars, then the method of evaluating the top-managers' motivation through the use of warrants is feasible. However, the forecast accuracy of itself, if only for 4 years ahead, must be performed by highly skilled analysts (as the same goes for absolute adequacy of the motivation value obtained by us and amounting to 0.847945 million US dollars).

7. Conclusion. It is possible to summarize the results of the research conducted in this article by formulating the following practical conclusions.

1. In today's economic environment, an important characteristic of top-echelon executives includes not only their qualification and business reputation but also their motivation for the company's development.

2. The majority of present-day investigators have come to a general consensus that for an objective evaluation of the top management's performance in a company, it is imperative for the results of this performance to be evaluated by the market, rather than by the subjective human factor (which is to say, by the top managers themselves).

3. Indexing managers' fees according to the company's stock value may be accomplished, for instance, by means of providing them with call options on shares. However, such a policy is dangerous since the managers are permitted to become the company's co-owners. That is why we advise to use non-deliverable options providing for no delivery of any underlying asset. In addition, options must be of the European type and confined to the project completion time. This will help avoid the managers' actions aimed at artificial overestimation of the results of their work, for instance, a short-term rise in the market price of shares in the company managed by them.

4. Motivating top managers by means of call options on shares in the company managed by them is fairly popular in the practice of the financial and academic community. However, stock call options issued to top managers are essentially different from conventional stock options. They are usually called warrants.

5. Even though evaluating top-managers' motivation through the use of warrants is certainly attractive, it stands to reason that this motivation, as any other, must have a certain value for the company. While the due date for new warrants will occur in the far future, the market is even now revaluating corporate securities on the basis of future opportunities. The common-stock value is adjusted with allowance for anticipated dilution that results from warrant exercise.

6. The Black–Scholes model is used in most cases in order to valuate European options, since it provides a conservative, i.e., lowest, option value. However, for more realistic corporate business presentation, a model with dividends for a European-type warrant should be used.

7. A methodological difficulty of this analysis is in the existence of a kind of an endless circle since for an estimated adjustment for any stock value dilution, it is required to know the warrant value, and for valuation of the warrant, it is again required to have an adjustment for the stock value dilution. This problem can be solved by starting the calculation process with an assumption in terms of the warrant value (for example, by taking the current market value of the warrant). This will provide an initial estimate of the stock value that can be then used as an input parameter for revaluation of the warrant value.

8. The stock and warrant values can be theoretically adjusted until the warrant value has become equal to zero. The stock value, however, will significantly decrease as compared to the original market value. But in practice, markets ineffectually respond to companies issuing warrants. Therefore, the stock value only decreases insignificantly. That is why it is recommended for practitioners to decide upon the adjustment of the fair stock price which would be following the first specification of the fair warrant price. In this case, the price of motivating top managers using warrants is calculated through multiplying the magnitude of reduction in the stock value by the number of the company shares in circulation.

9. The obtained top management motivation price should be compared with the current value of the company's market value growth for the planned period until the warrants are exercised. If it is expected that the current growth value exceeds the top management motivation price, then this method of motivation through the use of warrants is feasible.

The results obtained in this article may be useful to company owners and financial analysts. They help more efficiently motivate salaried corporate top managers comparing the price of their motivation with the predicted growth of the company business market value.

REFERENCES

1. **Porter M.E.** On competition. Boston, Harvard Business School Press, 1998. 485 p.

2. **Limitovsky M.A.** Reputation, qualification and motivation as value drivers. *Russian Management Journal*, 2009, no. 7(2), pp. 51–68. (rus)

3. **Limitovsky M.A., Lobanova E.N., Minasyan V.B., Palamarchuk V.P.** Corporate financial management: teaching and practical aid. Moscow, Urait, 2012. 990 p. (rus)

4. **Limitovskiy M.A.** Investment projects and real options in emerging markets: teaching and practical aid. 4th ed. Moscow, Urait, 2008. 464 p. (rus)

5. **Yashin S.N., Tukkel I.L., Koshelev E.V., Zakharova Yu.V.** Economics and financial support of innovative activities: textbook. In 2 vol. Vol. 2: financial support. Nizhni Novgorod, Lobachevsky University, 2016. 709 p. (rus)

6. **Limitovsky M.A.** Investment projects and real options in emerging markets: teaching and practical aid. Moscow, Delo, 2004. 527 p. (rus)

7. **Roche J.** The value of nothing: mastering business valuations. London, LES50NS (PUBLISHING) Limited, 2005. 236 p.

8. **Yashin S.N., Koshelev E.V., Kuptsov A.V., Podshibyakin D.V.** Investment planning of equipment upgrading in a manufacturing company: monograph. Nizhni Novgorod, RADONEZH Printing Shop LLC, 2015. 201 p. (rus)

9. **Hull J.C.** Options, futures and other derivatives.

Upper Saddle River. 6th ed. New Jersey, Pearson Prentice Hall, 2006. 814 p.

10. **Fisher A., Heinkel R.** Reputation and managerial truth-telling as self-insurance. *Journal of Economics & Management Strategy*, 2008, no. 17(2), pp. 489−540.

11. **Brigham E.F., Houston J.F.** Fundamentals of financial management. 12th ed. Mason, South-Western Cengage Learning, 2009. 755 p.

12. **Brigham E.F., Gapenski L.C.** Intermediate Financial Management. 4th ed. Orlando, FL, The Dryden Press, 1993. 1122 p.

13. **Marshall J.F., Bansal V.K.** Financial engineering: a complete guide to financial innovation. New York, Allyn & Bacon, Inc., 1992. 728 p.

14. **Kuznetsov B.T.** Investments. Moscow, Yuniti-Dana, 2006. 622 p. (rus)

15. **Damodaran A.** Investment valuation: tools and techniques for determining the value of any asset. New York, John Wiley & Sons, Inc., 2002. 993 p.

16. **Black F., Scholes M.** The pricing of options and corporate liabilities. *Journ. polit. econ.*, 1973, no. May−June 1973, pp. 637−657.

17. **Schafer D., Kruschwitz L., Schwake M.** Studienbuch finanzierung und investition. Munchen, Wien, R. Oldenbourg Verlag, 1998. 310 p.

18. **Cox J., Ross S., Rubinstein M.** Option pricing: a simplified approach. *Journal of financial economics*, 1979, no. 7, pp. 229−263.

19. **Burenin A.N.** Forwards, futures, options, adventive and yearly derivatives. Moscow, Scientific and Technical Society n.a. Academician S.I. Vavilov, 2005. 540 p. (rus)

20. **Chetyrkin E.M.** Financial mathematics: textbook. 10th ed. Moscow, Delo, 2011. 392 p. (rus)

21. **Anufriev I.E., Smirnov A.B., Smirnova E.N.** MATLAB 7. St. Petersburg, BHV-Petersburg, 2005. 1104 p. (rus)

22. **Polovko A.M., Butusov P.N.** MATLAB for a student. St. Petersburg, BHV-Petersburg, 2005. 320 p. (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Портер М.Э.** Конкуренция. М.: Изд. дом «Вильямс», 2005.

2. **Лимитовский М.А.** Репутация, квалификация и мотивация как драйверы ценности // Российский журнал менеджмента. 2009. Т. 7. № 2. С. 51−68.

3. **Лимитовский М.А., Лобанова Е.Н., Минасян В.Б., Паламарчук В.П.** Корпоративный финансовый менеджмент: учеб.-практ. пособие. М.: Юрайт, 2012.

4. **Лимитовский М.А.** Инвестиционные проекты и реальные опционы на развивающихся рынках: учеб.-практ. пособие. 4-е изд., перераб. и доп. М.: Юрайт, 2008.

5. **Яшин С.Н., Туккель И.Л., Кошелев Е.В., Захарова Ю.В.** Экономика и финансовое обеспечение инновационной деятельности: учебник. В 2 т. Т. 2: Финансовое обеспечение. Н. Новгород: Изд-во ННГУ им. Н.И. Лобачевского, 2016.

6. **Лимитовский М.А.** Инвестиционные проекты и реальные опционы на развивающихся рынках: учеб.-практ. пособие. М.: Дело, 2004.

7. **Рош Дж.** Стоимость компании: от желаемого к действительному. Минск: Гревцов Паблишер, 2008.

8. **Яшин С.Н., Кошелев Е.В., Купцов А.В., Подшибякин Д.В.** Инвестиционное планирование модернизации оборудования производственной компании: моногр. Н. Новгород: Печатная Мастерская РАДОНЕЖ, 2015.

9. **Халл Дж.К.** Опционы, фьючерсы и другие производные финансовые инструменты. 6-е изд. М.: Изд. дом «Вильямс», 2007.

10. **Fisher A., Heinkel R.** Reputation and managerial truth-telling as self-insurance // Journal of economics & management strategy, 2008, vol. 17, is. 2, pp. 489−540.

11. **Бригхэм Ю., Хьюстон Дж.** Финансовый менеджмент. 7-е изд. СПб.: Питер, 2013.

12. **Бригхем Ю., Гапенски Л.** Финансовый менеджмент: Полный курс: В 2 т. СПб.: Экон. школа, 2005.

13. **Маршалл Дж.Ф., Бансал В.К.** Финансовая инженерия: Полное руководство по финансовым нововведениям. М.: Инфра-М, 1998.

14. **Кузнецов Б.Т.** Инвестиции. М.: Юнити-Дана, 2006.

15. **Дамодаран А.** Инвестиционная оценка. Инструменты и техника оценки любых активов. М.: Альпина Бизнес Букс, 2004.

16. **Black F., Scholes M.** The pricing of options and corporate liabilities // Journ. polit. econ., 1973, May−June 1973, pp. 637−657.

17. **Крушвиц Л., Шефер Д., Шваке М.** Финансирование и инвестиции: сб. задач и решений. СПб.: Питер, 2001.

18. **Cox J., Ross S., Rubinstein M.** Option pricing: a simplified approach // Journal of financial economics, 1979, no. 7, pp. 229−263.

19. **Буренин А.Н.** Форварды, фьючерсы, опционы, экзотические и погодные производные. М.: Науч.-техн. общ-во им. акад. С.И. Вавилова, 2005.

20. **Четыркин Е.М.** Финансовая математика: учебник. 10-е изд. М.: Дело, 2011.

21. **Ануфриев И.Е., Смирнов А.Б., Смирнова Е.Н.** MATLAB 7. СПб.: БХВ-Петербург, 2005.

22. **Половко А.М., Бутусов П.Н.** MATLAB для студента. СПб.: БХВ-Петербург, 2005.

YASHIN Sergei N. − Lobachevsky State University of Nizhni Novgorod.
603950. Gagarin av. 23. Nizhny Novgorod. Russia. E-mail: jashinsn@yandex.ru

ЯШИН Сергей Николаевич − профессор, заведующий кафедрой «Менеджмент и государственное управление» Нижегородского государственного университета им. Н.И. Лобачевского, доктор экономических наук.
603950, пр. Гагарина, д. 23, г. Нижний Новгород, Россия. E-mail: jashinsn@yandex.ru

TRIFONOV Yurii V. − Lobachevsky State University of Nizhni Novgorod.
603950. Gagarin av. 23. Nizhny Novgorod. Russia. E-mail: trifonovyu052@gmail.com

ТРИФОНОВ Юрий Васильевич − профессор, заведующий кафедрой «Информационные технологии и инструментальные методы в экономике» Нижегородского государственного университета им. Н.И. Лобачевского, доктор экономических наук.
603950, пр. Гагарина, д. 23, г. Нижний Новгород, Россия. E-mail: trifonovyu052@gmail.com

KOSHELEV Egor V. − Lobachevsky State University of Nizhni Novgorod.
603950. Gagarin av. 23. Nizhny Novgorod. Russia. E-mail: ekoshelev@yandex.ru

КОШЕЛЕВ Егор Викторович − доцент Нижегородского государственного университета им. Н.И. Лобачевского, кандидат экономических наук.
603950, пр. Гагарина, д. 23, г. Нижний Новгород, Россия. E-mail: ekoshelev@yandex.ru

A.N. Tsatsulin, A.V. Babkin

MEASURING THE STRUCTURAL EFFECTS OF COST INFLATION IN INDUSTRY

А.Н. Цацулин, А.В. Бабкин

ИЗМЕРЕНИЕ СТРУКТУРНЫХ ЭФФЕКТОВ ИНФЛЯЦИИ ЗАТРАТ В ПРОМЫШЛЕННОСТИ

The article describes the methodical aspect of constructing index schemes for analyzing complex structured phenomena of an economic nature based on Varzar's ideology as two- or three-factor multipliers. The index method is widespread in branch-specific analytics, , in particular, in industrial branches of the real sector of the national economy. Using the group of price indices for measuring the dynamics of the actual production volumes, for analyzing the dynamics of purchase, wholesale, selling, contractual marketing, transfer and other prices and tariffs, for calculating the inflation during monitoring has been tested and has proved a trustworthy method; the theory behind the index method itself is well-developed in Russian statistical theory, which allows, in our opinion, to reliably measure the structural component of the inflationary spiral. It is studying the structure of cost inflation that is of special interest for academic economists in connection with searching for exit strategies from the protracted crisis. attribute factors. This article reveals for the first time a method for assessing the effect of cost inflation which forms the above-mentioned structural component, using as an example machinery manufacturing for two selected time periods and three specified attribute factors. For illustrating the construction of an index scheme, the paper presents visuals of the planar and the spatial procedures for analyzing the factor increments of the process of cost forming as an effect of combined changes, reflecting the structural features of the inflationary motion. he stages of the study conducted are provided with comprehensive commentary on the results of the analytical expansion of production costs with respect to its structure, unit costs and the prices of the purchased raw materials used. We believe that the advantages of the offered measurement technique are obvious.

INFLATIONARY PROCESS; INFLATION IN THE INDUSTRY; INFLATION OF EXPENSES AND EXPENSES; INDEX METHOD; ANALYTICAL INDEX; MULTIPLIER; SCHEME OF FACTORIAL ANALYSIS.

Представлен методический аспект построения индексных схем анализа сложных структурированных явлений экономической природы по идеологии В. Варзара в виде двух- и трехфакторного мультипликаторов. Широко распространен индексный метод в отраслевой аналитике, в частности в промышленных отраслях реального сектора национальной экономики. Традиционно надежное, испытанное использование группы ценовых индексов при измерении динамики физических объемов промышленного производства, анализе динамики закупочных, оптовых, отпускных, договорных сбытовых, трансфертных и иных цен и тарифов, исчисления уровня инфляции в режиме мониторинга, а также теоретическая разработанность собственно индексного метода в отечественной статистической теории позволяют достоверно измерить структурную компоненту инфляционной спирали. Именно изучение структуры инфляции затрат в последнее время представляет особый интерес в научном сообществе экономистов в связи с поиском путей выхода из надолго затянувшей кризисной ситуации. Впервые демонстрируется способ оценки эффекта инфляции затрат, который и формирует указанную структурную компоненту, на примере изготовления продукции машиностроительного профиля за два выделенных периода по трем учтенным признакам-факторам. В качестве наглядной интерпретации процедуры построения индексной схемы приведены графические иллюстрации плоскостной и пространственной процедуры анализа по-

факторных приращений процесса формирования затрат как эффекта совместных изменений, отражающего структурные особенности инфляционного движения. Изложенные этапы проведенного исследования снабжены содержательным комментарием к результатам аналитического разложения показателя себестоимости товарной продукции в отношении ее структуры, удельных издержек и цен на покупное используемое сырье.

ИНФЛЯЦИОННЫЙ ПРОЦЕСС; ИНФЛЯЦИЯ В ПРОМЫШЛЕННОСТИ; ИНФЛЯЦИЯ ИЗДЕРЖЕК И ЗАТРАТ; ИНДЕКСНЫЙ МЕТОД; АНАЛИТИЧЕСКИЙ ИНДЕКС; МУЛЬТИПЛИКАТОР; СХЕМА ФАКТОРНОГО АНАЛИЗА.

Introduction. It has been long noticed long by historians of science that there is an isomorphism between quantum physics and mathematical economy which relies on their general communication with mathematical statistics. The task of comparing various types of countable indicators and indices has currently become particularly relevant in the analytical methodology for assessing the development of the industrial sectors of the national economy. A special place in this methodology is held by a group of factorial analytical indices assessing the dynamics of prices, the inflationary spiral, the mobility of structural shifts and other statistical aspects of the economic processes happening in the national economy.

By nature of the tasks solved, composite indices are divided into the simple and the analytical. A simple index estimates the quantitative changes of some primary or secondary attribute without connection to other related attributes, and these analyzed (or indexed) factors are considered in the analysis as measured attribute factors, but summarily for each of the reporting periods.

An analytical index estimates the change of a productive attribute that happened due to a change in one of the considered attribute factors included in the aggregate analytical index. This method of constructing an analytical index is based on the statistical concept of *rigidly determined connections*. The change or the influence of other attribute factors taken into account in the analysis is in this case eliminated by the artificial fact that their level is fixed in a certain pre- stipulated period.

Let us consider as an example an elementary two-factorial multiplier linking in the form of a direct characteristic of statistical connection the amount of commodity turnover $W^{(j)}$ for a jth commodity position with the general variety of the commodity range $j = \overline{1, m}$, the physical sales volume (commodity weight in physical terms) $Q^{(j)}$ and the sale price for a commodity unit $p^{(j)}$. Their connection is defined in the so-called reporting and basic periods by the following multipliers

$$W_1^{(j)} = Q_1^{(j)} p_1^{(j)}; \quad W_0^{(j)} = Q_0^{(j)} p_0^{(j)}. \quad (1)$$

While no theoretical or technical problems arise concerning index analysis of the productive attribute $W^{(j)}$, the same cannot be claimed with certainty concerning the factorial analysis of the right part of the multiplier for two causal attribute factors from expressions (1), even in the rather trivial case when $k = 2$ (number of independent attribute factors).

Two approaches to solving this difficult question have been developed in the statistical theory of the index method. *The first approach* (regulated) connects the choice of the period of weights with the character and the nature of the indexed quantity. Namely, if the so-called *primary* attribute is indexed/analyzed in the aggregate, the corresponding 'weights' are fixed at the level of the basic period; if the *secondary* sign is indexed/analyzed, it is weighed according to the reported data of the weight characteristics.

Such procedure for creating analytical indices satisfactorily provides the interrelation of the indices of the productive attribute and the attribute factors, provides their *circular reducibility* both in relative terms and in absolute expressions of the numerically estimated factor increments. The considered procedure for creating factorial analytical indices historically generated the widely known rather universal and powerful method of economic analysis, the method *of chain substitutions* using a similar way of forming direct characteristics of statistical interrelations between attributes within the so-called I and II index systems. The analyzed interrelation is realized through the initial fairly

clear expression (2) in general over the considered commodity range of m positions

$$\mathfrak{I}_{W(Q,p)1/0} = \mathfrak{I}_{W(Q)1/0} \times \mathfrak{I}_{W(p)1/0} =$$

$$= \frac{\sum\limits_{j=1}^{m} Q_1^{(j)} p_0^{(j)}}{\sum\limits_{j=1}^{m} Q_0^{(j)} p_0^{(j)}} \times \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_1^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_1^{(j)}} = \qquad (2)$$

$$= \frac{\sum\limits_{j=1}^{m} Q_1^{(j)} p_1^{(j)}}{\sum\limits_{j=1}^{m} Q_0^{(j)} p_0^{(j)}} = \frac{\sum\limits_{j=1}^{m} W_1^{(j)}}{\sum\limits_{j=1}^{m} W_0^{(j)}}.$$

The first approach has the advantages and disadvantages which have been considered in detail by such researchers as Allen, Kauffman, Kazinets, Kevesh, Konyus, Rotstein, Ploshko, Tornquist, Frenkel, Edelgauz, Edgeworth, Marshall, Chetverikov, and others. Fischer's compound index, created in 1933 and modestly and unpretentiously called ideal by the author, was supposed to eliminate the disadvantages inherent to this approach; however, that did not happen. Nevertheless, this method for determining the weight period is standard in Russian and foreign official statistics and in the operational economic analysis though shortcomings of this approach are fairly obvious. For example, fixing weights in indices of the secondary attributes constructed according to regulations at the level of the reporting period creates artificial obstacles to objectively assessing how each isolated attribute factors was taken into account in dynamics.

For instance, when analyzing the change in the price factor in the $p_0^{(j)} \Rightarrow p_1^{(j)}$ dynamics, the index constructed by the reported weight characteristics takes into account, in addition to the change in the actual indexed quantity, the influence and the state of the weight $Q_1^{(j)}$, changed by the start of the reporting period, i.e., its *structural and quantitative determinacy* quantitative certainty, but for the dynamics of the subsequent period. This circumstance can be simplistically considered the main drawback of the traditional scheme of index analysis, established by regulations.

The second approach to determining the weight period in analytical indices assumes constructing all interconnected indices exclusively for basic period weights. This analytical approach is acceptable as it fully answers the purposes and problems of any study, i.e., to obtain the most reliable assessment of an isolated influence (action) of each of the considered causal attribute factors on the productive attribute factor provided that circular reducibility of all obtained index characteristics will be observed. Respectively, all considered attribute factors are one by one subjected to index analysis in a sequence set in some way , which is certainly reasonable substantially and taking into account the requirements of logical and substantial coordination.

Here it is interesting to note the application of both approaches to the creation of the classical *Paashe price indices* (from now on denoted with *P*), devised in 1874, and *Laspeyres price indices* (from now on denoted with *L*), introduced into scientific circulation even earlier in 1864. Both price indices are used in statistical practice, sometimes even at the same time, for measuring the cost of life, i.e., the monetary costs incurred for maintaining a certain standard of living in the above-mentioned *ideal*[1] index. The canonical form of these indices is shown in expressions (3)

$$\mathfrak{I}_{P_{1/0}}^{(P)} = \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_1^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_1^{(j)}}; \quad \mathfrak{I}_{P_{1/0}}^{(L)} = \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_0^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_0^{(j)}}. \quad (3)$$

The Paashe price indices, i.e., with weights of the reporting period, are calculated for a wider range of goods, works and services. Because weights of these indices are not the structure of consumer expenses, but the structure of either the commodity turnover, or the gross value added, or the production manufactured in the current period, the weights can be defined only after the reporting period. Therefore the Paashe index takes into account the results of the mutual substitution of economic benefits but does not reflect the simultaneous decrease in the welfare of the population.

---

[1] The Fisher index has a traditional form $\mathfrak{I}_{P_{1/0}}^{(F)} = \sqrt{\mathfrak{I}_{P_{1/0}}^{(L)} \times \mathfrak{I}_{P_{1/0}}^{(P)}}$ in the expressions presented in the paper

Problem setting. The index $\mathfrak{I}^{(P)}_{p_{1/0}}$ is used for measuring the dynamics of the prices of GDP components, purchase prices in agriculture, budget prices in construction, export-import prices, tariffs, etc. The Paashe index algorithm is also used for calculating such a major macroeconomic indicator as the deflator of gross domestic product, an index deflator, or *Gross Domestic Product deflator* (*GDP-deflator*) reflecting the relation of the nominal GDP volume to its real volume.

In the middle of the 20th century, Alexander Gershenkron, an American researcher of Russian origin, used both indices in the form of formulae from expression (3) for designing his own index by means of which he studied specific effects (*Gerschenkron's effect*) in the Soviet and the American economies during industrialization and World War II. The scientist thus made a noticeable contribution to the analysis of the interrelation of inflationary and structural processes. This index characteristic is often called the analytical price index according to Gershenkron's scheme ($\mathfrak{I}^{(G)}_{p_{1/0}}$) to distinguish it from the Paashe and Laspeyres price indices, and the characteristic has the following appearance and value:

$$\mathfrak{I}^{(G)}_{p1/0} = \mathfrak{I}^{(L)}_{p1/0} : \mathfrak{I}^{(P)}_{p1/0} =$$

$$= \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_0^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_0^{(j)}} : \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_1^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_1^{(j)}} > 1. \qquad (4)$$

The systematic lag of $\mathfrak{I}^{(P)}_{p1/0}$ from $\mathfrak{I}^{(L)}_{p1/0}$ fixed by the formula from expression (4) allowed the latter index to claim the role of the main inflationary indicator. Due to this circumstance, the Laspeyres index received the name of the *Consumer Price Index* (CPI)[2]. For price indices this is caused by the redistribution of demand from goods whose prices rise relatively faster to

goods whose relative prices, respectively, decrease in the studied periods.

The index $\mathfrak{I}^{(L)}_{p1/0}$ does not take into account the possibility of replacing more expensive goods with less expensive ones. The CPI represents one of the approaches to measuring the shifts in the prices of a market basket from an invariable set of goods and services. The CPI is the index indicator of an overall price level reflecting the change in the price of many consumer goods and services and representing the relation of the price of the consumer basket to its price in the basic year. The structure of the consumer basket, as appears from this definition, is fixed at the level of the basic period.

Interpreting the so-called Marshall-Edgeworth spatial and territorial index whose formula is also capable to catch shifts in the structure of production and sales is even more problematic. However, the aggregate of the index is attached to arbitrary structure of the weights, not typical for any of the real periods. Additionally, the technique of index calculation is known to encounter obstacles when statistical information is collected, so actually interpreting the literal economic sense is thus traditionally complicated.

The price indices calculated using the Laspeyres formula are especially widely applied for calculating producer price indices for industrial goods by the data on the prices of representative goods (the so-called comparable circle of elements of statistical observation). However, this index does not include investment goods, but takes into account the prices of import production. Another direction for using the $\mathfrak{I}^{(L)}_{p1/0}$ indicator is its inclusion in the inflation assessment model; for example, Gazprombank uses the so-called seasonally adjusted basic consumer price index (BCPIUS) in calculations of inflation for the bank's own purposes .

Inflationary processes in the national economy are estimated, as a rule, by means of the two above-described indices, and they are applied when data is generalized by unit of population (for example, by enterprises, regions, countries) or by element (for example, by types of goods), and also by units and elements. So, the 'Provision on the order of supervision over the change in prices and tariffs for goods and services and determining the consumer price index', approved by a Resolution of Goskomstat

---

[2] The main purpose of the CPI is to assess the dynamics of the consumer price. The resolution of the International Labor Organization (ILO) stipulates that 'the purpose of CPI calculation is the evaluation of the change in the general price level of goods and services acquired, used or paid for by the population for non-productive consumption over time'.

of the Russian Federation, it is specified that CPI is 'one of the major indicators characterizing the rate of inflation and is used for implementation of the state financial policy, the analysis and the forecast of price processes in economy, regulations of real rate of national currency, revision of the minimum social guarantees, solutions of legal disputes' [9].

Exact knowledge of the inflationary characteristics is extremely important for adopting reasonable political decisions with serious social consequences. For example, at meetings of the first half of 2015, representatives of the Ministry of Finance and Ministry of Economic Development suggested to index pensions in 2016−2018 only at the level of target inflation, that is, approximately by 4−5.5%, while official inflation in 2014 reached 11.4%, and was already planned at 12.2% in 2015 [11].

CPI is calculated weekly, monthly, or quarterly, and also as a year to date figure. Final CPI values in a month, quarter, or year are determined before the 15th of the month following the reporting period. One of the major problems concerning the substantial characteristic of the CPI is connected with determining the methodological approaches to establishing the size and structure of a consumer basket. Determining the size and choosing the structure of the consumer basket is a difficult problem whose solution is based on special statistical studies as the consumer basket has to reflect the structure of the consumed goods typical for a specific country, so that the change in the price of these goods could objectively show the direction of the economic processes occurring.

According to Rosstat's methodical guideline, the calculation of the CPI involves processing the information on consumer prices of 380 goods and services in 350 cities of the Russian Federation. The Russian version of the CPI includes all main groups of goods and services, covering 400 thousand quotations of prices and tariffs, 30 thousand enterprises of retail trade and rendering services. The set of the goods and services used for calculating the CPI includes goods and services of mass consumer demand, and also separate goods and services of optional use (cars, jewelry, and others). The composition of the analyzed consumer basket is made up of 26.2% foods, 52.6 % nonfoods, and 21.2 % paid services.

The structure of the consumer expenses of the population for the previous year is used as weights for the current year. The CPI is calculated using weights of the previous year which are updated every year. The main data source for obtaining the weights is the annually conducted examination of household budgets. Households are selected for budget inspection based on the principles of random sampling. The basis for the sample is made up of the information array created by the materials of the microcensus of population carried out in the Russian Federation 2012. The volume of the sample is 48.7 thousand households, i.e., about 0.1% of the total number of households in the Russian Federation.

The statistics involved in calculating the *CPI* index in the USA covers more than 19 thousand retail trading companies and 57 thousand households as a representative sample of about 80% of the population of the country. The consumer basket is made up of 44.1% goods and 55.9% services. As the sample for inspection covering goods and services of stable demand (food, clothes, fuel, transport, medical care, etc.) is sufficiently representative, we must agree with the opinion of analysts from statistical institutions both in the Russian Federation, and in other countries, in particular, in the USA (Bureau of Labor Statistics) that the CPI can actually be considered as the main indicator for measuring inflation. However, the specifics of the current crisis that the national economy is experiencing, in particular, the significant reduction in production volumes that began in 2015, necessitates paying close attention to measuring a specific type of inflation that is cost inflation.

Cost inflation in a market economy is caused by a short-term excess of the cumulative offer over the cumulative demand in connection with a sharp increase in prices for production factors. Such an increase, as a rule, is caused by either poor crops and a considerable rise in the price of exported raw materials, or by a heavy fall in the rate of the national currency. Even in a quasimarket economy, such a process is followed by reduction of outputs and growth of unemployment[3]. With invariable cumulative demand it can cause reduction of salary costs and decrease in other costs of production factors that can ultimately lead to reduction of prices.

---

[3] The unemployment rate in the Russian Federation is rapidly approaching 6.5% of economically active population.

If the money supply and the nominal expenses of the federal budget grow in a situation with these parameters, cumulative demand increases, and respectively, production volumes increase and unemployment is reduced, but there is a further increase in prices for end products in the chain of cost formation. A similar kind of inflation, as it is treated by the economic theory, is also produced when the key branches of the economy (with the specifics of a resource-based economy) often coinciding with the fields of activity of natural monopolies cease to function according to market laws and slip out of state control and regulation. Then these market agents set an increase in the prices and tariffs for their economic goods above the average increase of the prices.

Inflationary analysts point out that the growth rates of *monetary inflation* in crisis conditions significantly exceed the growth rates of structural inflation [12, 14−16]. Monetary inflation does not include seasonal and administrative influence on the prices. Structural inflation, as it should, reflects structural shifts in production and leads to an increase in prices mainly in the branches where the demand for production exceeds the commodity offer.

Analysts consider the weakening ruble to be a major factor increasing the monetary inflation, as its depreciation, besides the obvious rise in import prices, stimulates the acceleration of cash turnover. The latter circumstance in itself is capable of having inflationary consequences. An additional factor increasing monetary inflation is the *tendency* to consumption increasing in the conditions of unstable economy, which was discussed in our previous study [13]. The upward dynamics of this tendency, sometimes accompanied by speculative demand, is fed by a mistrust of legal entities and individuals to the unstable banking system and by noticeable inflationary expectations.

Coming back to the $\mathfrak{I}_{p_{1|/0}}^{(G)}$ index, we should note that Gershenkron's effect manifests itself not only in the analysis of prices and tariffs, but also in the analysis of quantities, i.e., physical volume, or commodity weight[4] and also in

studying the obligatory components of the temporal trend of the environment of indices of industrial production (indices of physical volume) which are calculated each month by the Analytical Center for the Government of the Russian Federation. Using only basic weights eliminates the main defect of the first approach. However, another problem emerges then, which is in ensuring the mutual coordination of the analytical indices (which we will from now on call the basic indices) in a coherent system suitable for indicating the phenomenon. The constructed factor indices do not generate such a system with the productive attribute index in their initial (pure) form. We will illustrate this difficulty using the example of the afore-mentioned commodity turnover with such a ratio from expression (5)

$$\mathfrak{I}_{W(Q)1/0} \times \mathfrak{I}_{W(p)1/0} \neq \mathfrak{I}_{W(Q,p)_{1/0}}.$$

$Q_0 \rightarrow Q_1$	$Q_0 = \mathrm{const}$	$Q_0 \rightarrow Q_1$
$p_0 = \mathrm{const}$	$p_0 \rightarrow p_1$	$p_0 \rightarrow p_1$

(5)

Research technique. These considerations serve as a convincing explanation of this seemingly natural result following from expression (5): the isolated assessment of the change in the separate factors does not take into account the circumstance that their actual changes $(Q_0^{(j)} \Rightarrow Q_1^{(j)}; \quad p_0^{(j)} \Rightarrow p_1^{(j)})$ happened in a real economic environment, in specific trade and commodity operations, and were carried out not only in combination but also interdependently. This circumstance causes the special statistical effect supplementing the effects of the isolated change of separate factors. It is obvious in the theory of economic analysis that such combined change of factors needs to be taken into account. The effect is measured according to Varzar's[5] scheme in the form of the *Index of Joint Changes (IJC)* with its different modifications used for different analytical tasks.

---

[4] Gershenkron's effect is one of the so-called transformational effects observed in the course of the change of the structure of a developing economic system;it consists in reduction of values of a production index with transition to weights of later periods, since goods whose production grows in advancing rates are usually characterized by decreasing relative prices.

[5] Vassily Egorovich Varzar (1851−1940) was a Russian and Soviet statistician and economist, academician, the founder of industrial statistics in Russia. He organized two first large statistical inspections (censuses) of the Russian industry in 1900 and in 1908.
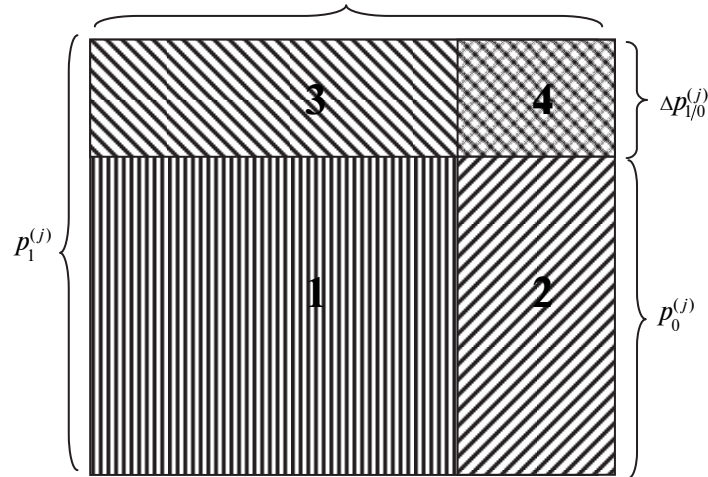
Fig. 1. Graphical representation of Varzar's index of joint changes (IJC)

Let us consider a plane illustration of the diagram, or Varzar's sign" on the example of commodity turnover, i.e., with respect to the two-factorial multiplier from expression (1). The diagram shown on the plane is oriented at the two-factorial multiplicative model. Basic and reporting conditions of the cost volume of commodity turnover of a jth commodity coincide by their meaning with the areas of the rectangles with the respective sides $\{Q_0^{(j)}, p_0^{(j)}\}$ and $\{Q_1^{(j)}, p_1^{(j)}\}$. The transition of the commodity turnover volume from the basic state $W(Q_0^{(j)}, p_0^{(j)})$ to the reporting one $W(Q_1^{(j)}, p_1^{(j)})$ geometrically means the change of the initial area (rectangle 1) W_0 due to the addition of three more areas as it is presented in Fig. 1.

$$W(Q_1^{(j)}, p_1^{(j)}) = W(Q_0^{(j)}, p_0^{(j)}) +$$
$$+ W(\Delta Q_{1/0}^{(j)}, p_0^{(j)}) + W(\Delta p_{1/0}^{(j)}, Q_0^{(j)}) + \qquad (6)$$
$$+ W(\Delta Q_{1/0}^{(j)}, \Delta p_{1/0}^{(j)}).$$

To find an absolute increment of the commodity turnover volume in the reporting period in comparison with the basic one, it is necessary to transfer its basic characteristic $W(Q_0^{(j)}, p_0^{(j)})$ to the left part of expression (6), respectively, with an opposite sign

$$\Delta W(Q^{(j)}, p^{(j)})_{1/0} = W(Q_1^{(j)}, p_1^{(j)}) -$$
$$- W(Q_0^{(j)}, p_0^{(j)}) = W(\Delta Q_{1/0}^{(j)}, p_0^{(j)}) + \qquad (7)$$
$$+ W(\Delta p_{1/0}^{(j)}, Q_0^{(j)}) + W(\Delta Q_{1/0}^{(j)}, \Delta p_{1/0}^{(j)}).$$

1 is the initial volume of cost of commodity turnover, or output in the basic period (previous year); 2 is the change of cost due to the growth of commodity weight in the reporting period (current year); 3 is the change of cost due to the change of the price factor; 4 is the change of

cost due to simultaneous and combined change both of the physical volume and the price

Expression (7) represents a differential form of the corresponding simple and analytical indices (i.e., in absolute expression) each of which has its own special purpose and semantic meaning. Upon transition to the traditional form of analytical indices in relative expression, each of which corresponds to differential forms from expression (7) as separate components, the so-called III Index system is formed which is oriented at taking into account the phenomenon of combined changes (rectangle 4 in Fig. 1), and this allows to measure Varzar's effect.

$$\Im_{W(Q,p)1/0} = \Im_{W(Q)1/0} \times \Im_{W(p)1/0} \times$$

$Q_0 \to Q_1$	$Q_0 \to Q_1$	$Q_0 = \text{const}$
$p_0 \to p_1$	$p_0 = \text{const}$	$p_0 \to p_1$

$$\times \Im_{W(\Delta Q_{1/0}, \Delta p_{1/0})1/0} = \frac{\sum_{j=1}^{m} Q_1^{(j)} p_0^{(j)}}{\sum_{j=1}^{m} Q_0^{(j)} p_0^{(j)}} \times \frac{\sum_{j=1}^{m} p_1^{(j)} Q_0^{(j)}}{\sum_{j=1}^{m} p_0^{(j)} Q_0^{(j)}} \times$$

$$\times \left[\frac{\sum_{j=1}^{m} p_1^{(j)} Q_1^{(j)}}{\sum_{j=1}^{m} p_0^{(j)} Q_1^{(j)}} : \frac{\sum_{j=1}^{m} p_1^{(j)} Q_0^{(j)}}{\sum_{j=1}^{m} p_0^{(j)} Q_0^{(j)}} \right].$$

$$(8)$$

Writing the component in square brackets of the formula from expression (6) allows to obtain two significant modifications of the index of joint changes $\Im_{W(\Delta Q_{1/0}, \Delta p_{01/0})1/0}$. The first modification presents is actually Varzar's index $(\Im_{p_{1/0}}^{(V)})$ itself in the form of a ratio inverse to Gershenkron's index, i.e., quantitatively

characterizing the systematic lag of the Paashe price index (P) from the Laspeyres index (L).

$$1) \quad \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_1^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_1^{(j)}} : \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_0^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_0^{(j)}} = \Im_{p1/0}^{(V)}. \quad (9)$$

This means that the index of joint changes from expression (9) apparently represents the relation of two other above-mentioned price indices stated to the corresponding value of their ratio:

$$\Im_{p1/0}^{(V)} = \Im_{p1/0}^{(P)} : \Im_{p1/0}^{(L)} < 1. \quad (10)$$

This analytical characteristic allows to estimate the dynamics of the changing prices calculated for the reporting and the basic range of the produced and sold commodity weight that is extremely important for identifying the deterioration/improvement of the quality of consumption of paid goods by the population and, ultimately, the quality of life. We should also note that the indices $\Im_{P1/0}^{(G)}$ and $\Im_{P1/0}^{(V)}$ are inversely proportional, which follows from expressions (4) and (10) and still allows to trace the influence of structural shifts in the commodity assortment on the price level and inflationary expectations in any set sequence.

Another modification of the index of joint changes can be obtained based on expression (7) as initial by using an analytical technique of the so-called *replacement of the elements of the minor diagonal* and subsequently rearranging the multipliers in numerators and denominators of the respective indices of physical volume, $\Im_{Q(P_1)1/0}$ and $\Im_{Q(P_0)1/0}$.

$$2) \quad \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_1^{(j)} \quad \sum\limits_{j=1}^{m} p_1^{(j)} Q_0^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_1^{(j)} \quad \sum\limits_{j=1}^{m} p_0^{(j)} Q_0^{(j)}} =$$

$$= \frac{\sum\limits_{j=1}^{m} p_1^{(j)} Q_1^{(j)}}{\sum\limits_{j=1}^{m} p_1^{(j)} Q_0^{(j)}} : \frac{\sum\limits_{j=1}^{m} p_0^{(j)} Q_1^{(j)}}{\sum\limits_{j=1}^{m} p_0^{(j)} Q_0^{(j)}} = \quad (11)$$

$$= \frac{\sum\limits_{j=1}^{m} Q_1^{(j)} p_1^{(j)}}{\sum\limits_{j=1}^{m} Q_0^{(j)} p_1^{(j)}} : \frac{\sum\limits_{j=1}^{m} Q_1^{(j)} p_0^{(j)}}{\sum\limits_{j=1}^{m} Q_0^{(j)} p_0^{(j)}} = \Im_{Q(p_1/p_0)1/0}.$$

During these elementary transformations we obtained two indices of physical volume of commodity weight for the reporting and the basic level of pricing whose ratio yields the second modification of Varzar's index of joint changes better known as *the index of shift of the commodity range* (not to be confused with the second analytical index that is the structure index, or the index of structural shift from the I Index system).

Both modifications of the index of joint changes (Varzar's index and Index of shift of the commodity range) account from different positions for the combined price change and the commodity weight with respect to commodity turnover which 'with the same rate of success and equally unreasonably' can be attributed to both the first and the second factor. The modifications convincingly demonstrate the diversity of index measurement, the arbitrariness of certain index characteristics, the objective limitation of the sphere and at the same time the specific requirements for applying each of them. Creating the index of joint changes upon transition from the planar to the volume standpoint, i.e., carrying out similar procedures concerning the three-factorial multiplier, can cause difficulties regarding substantial interpretation even for an experienced researcher.

For example, for the model of the direct characteristic of the statistical relation of raw material costs in the production of a *j*th detail $C(j)$, its dependence on the number of details $Q(j)$; the specific cost of raw materials $s^{(i)}$ and the price per unit of raw materials $p^{(i)}$ for the entire range of manufactured products, respectively, formulae from expression (12) in the reporting and basic periods of the processing departments of a machine-building enterprise hold true

$$\sum\limits_{j=1}^{m} C_0^{(j)} = \sum\limits_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_0^{(j)};$$

$$\sum\limits_{j=1}^{m} C_1^{(j)} = \sum\limits_{j=1}^{m} Q_1^{(j)} s_1^{(j)} p_1^{(j)}. \quad (12)$$

There is no other possible combination of attribute factors as economically and

substantially coherent indicators can be obtained only in the set sequence: first, the *physical volume* of raw materials used for producing a jth detail of the form $Q(j) \times s^{(j)}$, and then the *cost* of the current assets spent per volume of production $(Q^{(j)} \times s^{(j)}) \times p^{(j)}$. The structural transition from a basic assessment (state) of the overall costs of raw materials to the actual expenses of the reporting period can be shown by analogy with the sequence of calculating operations in Fig. 1 on the scheme of forming the index of joint changes in a three-dimensional space $\{Q, m, p\}$ in Fig. 2.

In the three-dimensional visual in Fig. 2, the areas of the base of an arbitrary parallelepiped in the form of the quantity of the raw materials spent on manufacturing a jth type of production are geometrically estimated at first, then the volume parameters of the attributes numerically coinciding with the cost $C^{(j)}$ are calculated. In this case the summary index of the change of cost of expenses in the reporting period (for example in a day, week, month, quarter, etc.) will have in comparison with the basic form within the III Index system (of basic indices) the following appearance containing a comment (in frames) under each

of the analytical indices in formulae from expression (13):

$$\Im_{C(Q,s,p)1/0} = \Im_{C(Q)1/0} \times \Im_{C(s)1/0} \times \Im_{C(p)1/0} \times$$

$Q_0 \Rightarrow Q_1$	$Q_0 \Rightarrow Q_1$	$Q_0 = \mathrm{const}$	$Q_0 = \mathrm{const}$
$s_0 \Rightarrow s_1$	$s_0 = \mathrm{const}$	$s_0 \Rightarrow s_1$	$s_0 = \mathrm{const}$
$p_0 \Rightarrow p_1$	$p_0 = \mathrm{const}$	$p_0 = \mathrm{const}$	$p_0 \Rightarrow p_1$

$$\times \Im_{C(\Delta Q, \Delta s, \Delta p)1/0} = \frac{\sum_{j=1}^{m} Q_1^{(j)} s_0^{(j)} p_0^{(j)}}{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_0^{(j)}} \times$$

$$\times \frac{\sum_{j=1}^{m} Q_0^{(j)} s_1^{(j)} p_0^{(j)}}{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_0^{(j)}} \times \frac{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_1^{(j)}}{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_0^{(j)}} \times$$

$$\times \left\{ \left[\frac{\sum_{j=1}^{m} Q_1^{(j)} s_1^{(j)} p_1^{(j)}}{\sum_{j=1}^{m} Q_1^{(j)} s_1^{(j)} p_0^{(j)}} \times \frac{\sum_{j=1}^{m} Q_1^{(j)} s_1^{(j)} p_0^{(j)}}{\sum_{j=1}^{m} Q_1^{(j)} s_0^{(j)} p_0^{(j)}} \right] : \right. \quad (13)$$

$$\left. : \left[\frac{\sum_{j=1}^{m} Q_0^{(j)} s_1^{(j)} p_0^{(j)}}{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_0^{(j)}} \times \frac{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_1^{(j)}}{\sum_{j=1}^{m} Q_0^{(j)} s_0^{(j)} p_0^{(j)}} \right] \right\}.$$
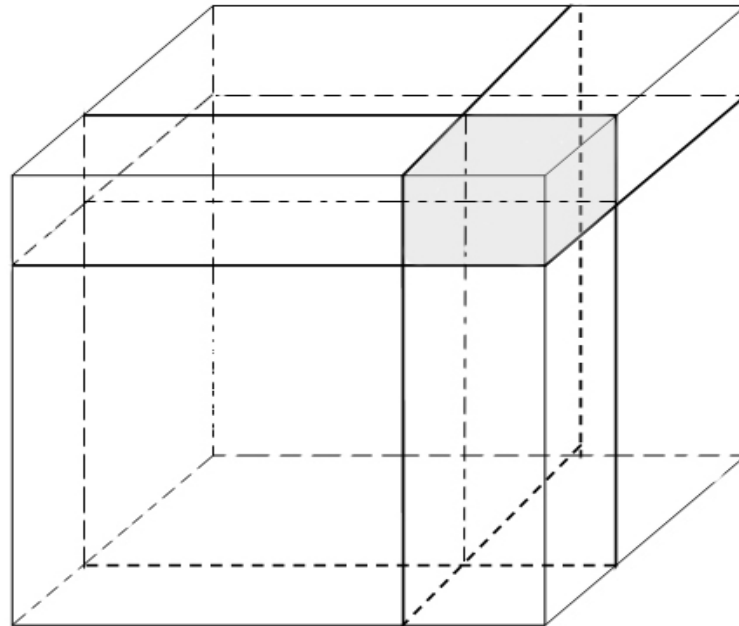

Fig. 2. 3D illustration of the procedure of creating the index of joint changes in the costs of the current assets consumed in production in the space of variables $\{Q, s, p\}$.

**Basic data for analyzing the cost index of material costs of a machine-tool manufacturing enterprise
by the index method of the three-factorial multiplier**

Item no.	Name of the detail in the commodity range	Basic period			Reporting period		
		number, units	rate of consumption, kg/unit	raw material costs, rub/kg	quantity, units	rate of consumption, kg/unit	raw material costs, rub/kg
$j = \overline{1, m}$	j	$Q_0^{(j)}$	$s_0^{(j)}$	$p_0^{(j)}$	$Q_1^{(j)}$	$s_1^{(j)}$	$p_1^{(j)}$
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Valve saddle	3 000	2,5	3 132	2 900	2,2	3 256
2	Unit roll	2 000	5,5	862	1 700	5,0	911

It follows from expressions (11) and (13) that the index of joint changes in this form represents the relation of a number of indices such as the dynamics of the prices and the specific costs of raw materials used in production according to both the Paashe scheme and the Laspeyres schemes:

$$\Im_{C(\Delta Q, \Delta s, \Delta p)1/0} = \frac{\Im_{s1/0}^{(P)} \times \Im_{p1/0}^{(P)}}{\Im_{s1/0}^{(L)} \times \Im_{p1/0}^{(L)}}. \quad (14)$$

However, the same formula from expression (14) allows to write an identical notation through two Varzar indices for the changes of the specific costs of raw materials and the change of costs of the same raw materials with respect to the component in curved braces of expression (13)

$$\Im_{C(\Delta Q, \Delta s, \Delta p)1/0} = \Im_{p1/0}^{(V)} \times \Im_{s1/0}^{(V)}. \quad (15)$$

These very interesting and substantial ratios of factorial aggregates from expression (14) allow to create a rich set of index combinations of different analytical orientations when determining research problems and use them to carry out complex technical and economic analysis of the dynamics of primary and secondary attributes of any depth and specification when diagnosing the economic performance of an enterprise at the microlevel of the economic subject, or the real sector of economy on meso- and macrolevels of regional and national economy.

Let us illustrate the above-discussed by an arbitrary example for which the data is presented in Tab. 1.

Having carried out the necessary analytical calculations for the traditional regulations and for Varzar's scheme, let us construct a table of summary characteristics from the obtained results. It follows from the data of column 5 of this table that with the general reduction of commodity mass

of the producer (-6.69%) reflecting in general the crisis state of the real sector of economy, the specific production generates inflationary processes, and the gain of costs due to increase in prices amounted to 4.42%. This can lead to a deceptive impression of rationalization of production against the general decrease in enterprise costs for these types of products (-13.51%).

Analytical calculations of the dynamics of the aggregated CPI levels and the intensity of inflationary processes can be another area of application for the index of joint changes. A separate direction of using the III Index system can be in fine analysis of the formation of costs and expenses in management accounting, including from modern positions of cost management and adopting reasonable administrative decisions aimed at regimes of savings and innovation of technologies and/or production.

We should also specifically mention the analytical potential of the discussed calculation indices with respect to studying the influence of inflation, which has been increasing in the last months, on the standard of living of various segments of the population. The process of inflation is many-sided, its character is similar to chain reactions in physics, and it can manifest itself in the following directions and positions: 1) increase in prices; 2) devaluation of the ruble in a relatively stable economy; 3) growth of the dollar and euro rates in an absolutely unstable economy; 4) rise in the price of prime costs of gross output and wholesale selling price per unit of commodity weight; 5) inflation of the financial 'bubble' of the economic subject to exceed the standard/recommended level with respect to real assets; 6) sharp reduction of the liquidity of all types of assets of stock markets; 7) excess transaction losses, and missed benefits of modern management.

It is the opinion of the scholars of the Institute of statistics of Rosstat [4, p. 79] that a unified system of measures, instead of separate steps, should be introduced to combat inflation. The differentiated inflation indices constructed on the basis of the IJC technique, including share, currency and similar indices, can indicate which measures should be taken against inflation. These indicators can serve to construct economic tools and adequate mechanisms of compensating for inflationary losses already under state regulation mediated by the megaregulator.

The obtained results. Similar indices can be used to solve the problem of practical implementation of methods for refining the financial statements of an economic subject (for example, for assessing the market value) in the conditions of inflation, which is directly connected with calculating the price index useful for recalculating the indicators of financial statements. Therefore, determining the method for measuring inflation or choosing the statistical indicators reflecting the size of inflationary processes in national economy is one of the most important stages in developing theoretical and methodical bases for updating the financial statements with the purpose of ensuring their comparability and reliability. The degree to which the choice of the indicators describing inflationary processes is scientifically based largely influences the validity of the subsequent assessment procedures.

The considered method for assessing the influence of structural shifts on the level of inflationary expectations can turn out to be in unexpected demand, as on November 10, 2014, the Central Bank of the Russian Federation changed its priorities, and declared the rate of inflation instead of the rate of national currency the main reference point of currency and monetary policy. Practice of te currency corridor which involved the megaregulator buying and selling currency, manipulating the ruble exchange rate, was in effect in the Russian Federation since 1995. Now the so-called *key rate* has become the main instrument of managing the money supply, i.e., aggregates of monetary economy, for the Central Bank of the Russian Federation.

Analyzing the recommendations for adjusting the financial statements contained in publications of the Russian authors showed that the absolute majority suggests using the account model in real terms *(GPP)* and applying the SPI within this model as an index of inflation. However, a number of publications discussing methodical

questions of procedures in the conditions of inflation based on the CPI may contain both contentious clauses, and opinions demanding open scientific discussion [10, 15, 16].

The formula of the index of joint changes from expression (14) can be also presented in the form of an extremely useful modification through Varzar's analog indices which flexibly assess the changes of the secondary attributes: the specific costs of the current assets ($s^{(j)}$) and the single price of raw materials ($p^{(j)}$)

$$\Im_{C(\Delta Q, \Delta s, \Delta p)1/0} = 1 / (\Im_{s1/0}^{(G)} \times \Im_{p1/0}^{(G)}). \qquad (16)$$

In this case the initial record of the simple index of cumulative costs for using current assets in industrial production according to expression (16) takes the form which is complete and almost classical, and, more importantly, convenient for analytical work and subsequent economic interpretation:

$$\Im_{C(Q,s,p)1/0} = \Im_{C(Q)1/0} \times \Im_{C(s)1/0} \times$$
$$\times \Im_{C(p)1/0} \times \Im_{s1/0}^{(V)} \times \Im_{p1/0}^{(V)}. \qquad (17)$$

The formula from expression (16) allows to separately estimate the structural changes of attribute factors s and p through the corresponding Gershenkron indices in the form of the following characteristics

a) influences of structure of the prices

$$\Im_{p1/0}^{(G)} = \Im_{C(Q)1/0} \times \Im_{C(s)1/0} \times \Im_{C(p)1/0} \times$$
$$\times \Im_{s1/0}^{(V)} / \Im_{C(Q,s,p)1/0}; \qquad (18)$$

b) influences of structure of expenditure of current assets

$$\Im_{s1/0}^{(G)} = \Im_{C(Q)1/0} \times \Im_{C(s)1/0} \times \Im_{C(p)1/0} \times$$
$$\times \Im_{p1/0}^{(V)} / \Im_{C(Q,s,p)1/0}. \qquad (19)$$

The material discussed in article is not presented in didactic literature and is our own methodical development. Such an approach to constructing the III Index system can be useful to practicing economists, financial and market analysts, and also researchers wishing to master the index method independently as a reliable statistical instrument of social and economic studies, in particular, the technique of analyzing the index of joint changes in its different subject modifications when investigating structural inflation.

Conclusions. While a wide variety of indices currently exist, the IJC technique allows to not only perform theoretically reliable calculations,

but also to receive finer (though more labor-consuming) measurement results for term papers and projects, final qualification works, dissertation and applied studies with any imaginable set of causal attribute factors of any dimension, without resorting to specific statistical approaches of multiple correlation and constructing regression equations [13].

It is particularly noteworthy that calculating the influence of the physical output, the specific expenses of current assets and the prices of materials slightly differ from estimates by the traditional (procedural) method. However, the authors consider the assessment of the characteristic of cost inflation produced by a specific unit of an industrial enterprise that is obtained through the IJC technique to be more reliable.

Directions of further research. The approach presented allows to generalize the analytical procedure of decomposition for a *k*-dimensional case without using overly complex mathematical tools, as the purpose of any analytic didactics implies subsequent synthetic generalization. The considered approach also comprises opportunities for assessing the influence of the attribute factors accounted for not only in the traditional relative form (as a percentage), but also, more importantly and more convincing for the management of analytical services and top management of the enterprise, in terms of absolute value through differential forms of special analytical indices. In our opinion, this is can be possibly carried out not only at a microeconomic level of an economic entity in industries, but also at the macrolevel of the national economy.

REFERENCES

1. **Ploschko B.G.** Gruppirovk's flat dish and systems of statistics. Indices. Moscow, Statistics, 1971. 177 p. (rus)

2. **Kazinets L.S.** Growth rates and structural shifts in economy (indicators of planning and statistics). Moscow, Economy, 1981. 184 p. (rus)

3. General theory of statistics. Textbook. 5th prod. Under the editorship of I. I. Yeliseyeva. Moscow, Finance and statistics, 2011. 675 p. (rus)

4. About work of section of statistics of TsDU Russian Academy of Sciences. Statistics questions, 2009, no. 9. (rus)

5. **Varzar V.E.** New way of creation of indicative charts, 2 ed. Moscow, 1926. (rus)

6. Vasily Egorovich Varzar − the scientist, the practician, the public figure: to the 150 anniversary since birth. Collection of scientific works. The Petersburg state. university of economy and finance. St. Petersburg, SPbGEU, 2001. (rus)

7. **Tsatsulin A.N.** Ekonomichesky analysis. Textbook. Vol. 1. 2nd ed. St. Petersburg, Piter, 2015. 704 p. (rus)

8. **Tsatsulin A.N.** Metodichesky aspect of studying of an index of joint changes. *Sb. materials of scientific and methodical conference: the Annual periodical included in the Russian Index of Scientific Citing (RISC).* St. Petersburg, SZAGS, 2011, pp. 118−130. (rus)

9. The provision on an order of supervision over the change in price and tariffs for goods and services, definitions of a consumer price index : The resolution of Goskomstat of Russia no. 23 of March 25, 2002. (rus)

10. The International Statistical Institute. URL: http://www.isi-web.org/.

11. URL: https://news.mail.ru/politics/22661749/?frommail=1 (accused July 15, 2015). (rus)

12. **Shapovalov A.** Monitoring: inflation in Russia became monetary. *The Businessman*, July 11, 2008, no. 226. (rus)

13. **Tsatsulin A.N., Babkin A.V.** An iterative procedure of consumer research in a narrow market segment. *St. Petersburg State Polytechnical University Journal. Economics*, 2015, no. 5(228), pp. 108−117. DOI: 10.5862/JE.228.11

14. **Babkin A.V.** Methods of an assessment of economic capacity of the industrial enterprise. *St. Petersburg State Polytechnical University Journal. Economics*, 2013, no. 1−2(163), pp. 138−148. (rus)

15. **Alexandrova A.V., Androsenko N. V., Basarev V.G., Bakhmutskaya A.V., Borisov A.A., Vertakova Yu.V., Volkova A.A., Glukhov V.V.,** etc. Economy and industrial policy: theory and Tools. Collective monograph. Under the editorship of the dr. econ. sciences, prof. A.V. Babkin. St. Petersburg, Publishing house SPbGPU, 2014. 612 s.

16. **Kharlamova T.L., Novikov A.O., Babkina N.I., Krasnyuk L.V., Osmanova A.M., Kuznetsova O.P., Yumayev E.A., P.B. Bulatov P.V., Saktoyev V.E., Haltayeva S.R., Bukhvald E.M., Oborina E.D., Rudenko M.N.** Globalization of economy and development of the industry: theory and Practice: the Collective monograph. Under the editorship of the Dr. econ. sciences, prof. A. V. Babkin. St. Petersburg, Publishing house SPbGPU, 2013. 386 p. (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Плошко Б.Г.** Группировка и системы статистических показателей. Индексы. М.: Статистика, 1971. 177 с.

2. **Казинец Л.С.** Темпы роста и структурные сдвиги в экономике (показатели планирования и статистики). М.: Экономика, 1981. 184 с.

3. Общая теория статистики: учебник. 5-е изд. / под ред. И.И. Елисеевой. М.: Финансы и статистика, 2011. 675 с.

4. О работе секции статистики ЦДУ РАН // Вопросы статистики. 2009. № 9.

5. **Варзар В.Е.** Новый способ построения показательных диаграмм. 2-е изд. М., 1926.

6. Василий Егорович Варзар — ученый, практик, общественный деятель: к 150-летию со дня рождения : сб. науч. тр. Петербургский гос. университет экономики и финансов. СПб.: Изд-во СПбГЭУ, 2001.

7. **Цацулин А.Н.** Экономический анализ: учебник. Т. 1. 2-е изд. СПб.: Питер, 2015. 704 с.

8. **Цацулин А.Н.** Методический аспект изучения индекса совместных изменений // Сб. матер. науч.-метод. конф. : Ежегодное периодическое издание, включенное в Российский индекс научного цитирования (РИНЦ). СПб.: СЗАГС, 2011. С. 118—130.

9. Положение о порядке наблюдения за изменением цен и тарифов на товары и услуги, определения индекса потребительских цен : Постан. Госкомстата России № 23 от 25 марта 2002 г.

10. The International Statistical Institute. URL http://www.isi-web.org/

11. URL https://news.mail.ru/politics/22661749/?frommail=1 (дата обращения: 15.07.2015).

12. **Шаповалов А.** Мониторинг: инфляция в России стала монетарной // Коммерсант. 2008. 11 дек. № 226.

13. **Цацулин А.Н., Бабкин А.В.** Об одной итерационной процедуре исследования потребительского спроса на узком рыночном сегменте// Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2015. № 5(228). С. 108—117. DOI: 10.5862/JE.228.11

14. **Бабкин А.В.** Методы оценки экономического потенциала промышленного пред-приятия // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2013. № 1—2(163). С. 138—148.

15. **Александрова А.В., Андросенко Н.В., Басарева В.Г., Бахмутская А.В., Борисов А.А., Вертакова Ю.В., Волкова А.А., Глухов В.В.** и др. Экономика и промышленная политика: теория и инструментарий : колл. моногр. / под ред. д-ра экон. наук, проф. А.В. Бабкина. СПб.: Изд-во СПбГПУ, 2014. 612 с.

16. **Харламова Т.Л., Новиков А.О., Бабкина Н.И., Краснюк Л.В., Османова А.М., Кузнецова О.П., Юмаев Е.А., Булатов Р.В., Сактоев В.Е., Халтаева С.Р., Бухвальд Е.М., Оборина Е.Д., Руденко М.Н.** Глобализация экономики и развитие промышленности: теория и практика : колл. моногр. / под ред. д-ра экон. наук, проф. А.В. Бабкина. СПб.: Издво СПбГПУ, 2013. 386 с.

TSATSULIN Aleksandr N. — North-West Institute of Management.
199178. Sredniy av. 57/43. Vasilyevsky Island. St. Petersburg. Russia. E-mail: vash_64@mail.ru

ЦАЦУЛИН Александр Николаевич — профессор Северо-Западного института управления Российской академии народного хозяйства и государственной службы при Президенте РФ, доктор экономических наук.
199178, Средний пр. В.О., д. 57/43, Санкт-Петербург, Россия. E-mail: vash_64@mail.ru

BABKIN Alexander V. — professor of the Higher school of industrial management and economy of the St. Petersburg polytechnical university of Peter the Great, the Doctor of Economics, professor.
195251, Politekhnicheskaya str. 29. St. Petersburg. Russia. Phone: 8(812)591-66-58. E-mail: babkin@spbstu.ru, al-vas@mail.ru

БАБКИН Александр Васильевич — профессор Высшей школы промышленного менеджмента и экономики Санкт-Петербургского политехнического университета Петра Великого, доктор экономических наук, профессор;
195251, ул. Политехническая, д. 29, Санкт-Петербург, Россия. Тел.: 8(812)591-66-58. E-mail: babkin@spbstu.ru, al-vas@mail.ru

I.L. Litovchenko, I.A. Shkurupskaya

INVESTIGATION OF THE INFLUENCE OF CONSUMER BEHAVIOR ON THE FORMATION OF INTEGRATED MARKETING COMMUNICATIONS

И.Л. Литовченко, И.А. Шкурупская

ИССЛЕДОВАНИЕ ВЛИЯНИЯ ПОВЕДЕНИЯ ПОТРЕБИТЕЛЕЙ НА ФОРМИРОВАНИЕ ИНТЕГРИРОВАННЫХ МАРКЕТИНГОВЫХ КОММУНИКАЦИЙ

This study is devoted to the theoretical and practical basis for creation of the integrated marketing communication (IMC) for enterprises at the B2B markets. Historical stages of integration of marketing communications, as well as the reasons for the transition to the IMC are considered. Analysis of multiple formulations revealed a trend in the development of the concept in the context of achieving the communicational, economic and social goals of the IMC. A main feature of the integrated marketing communications is a binary of their nature: combining channels and means of promotion — as exists in the real and in the virtual economy (due to Internet space). In our view, trends in the development of integrated marketing communications are identified. We have identified 15 motives acquisition of solar energy conversion equipment (as particular example of product in B2B market) to study their influence to the formation of integrated marketing communications. The objective structure of the purchasing reasons for recreational, agricultural and building segments of B2B-consumers in Ukraine was established on the basis of expert assessments. However, there are certain barriers to the willingness of consumers to current and future overpayments savings by using solar energy. The separation of the target audience on the scope of B2B and B2C allows arguments to rank the importance of various marketing activities within the IMC.

INTEGRATED MARKETING COMMUNICATION; CONSUMER BEHAVIOR AT B2B MARKETS; PURCHASING MOTIVES AT THE MARKET OF INDUSTRIAL PRODUCTS; UKRAINIAN SOLAR ENERGY CONVERSION EQUIPMENT MARKET.

Исследование посвящено теоретическим и практическим основам для создания интегрированных маркетинговых коммуникаций (ИМК) для предприятий на B2B рынках. исследованы теоретические подходы основ концепции интегрированных маркетинговых коммуникаций, предложено уточнение предмета ИМК, сделан акцент на бинарности их происхождения (реальной и виртуальной), а также на триединой цели применения ИМК предприятием. Рассмотрены исторические стадии интеграции маркетинговых коммуникаций, а также причины перехода к ИМК. Изучены особенности поведения потребителей в контексте достижения коммуникативных, экономических и социальных целей ИМК. Главной особенностью интегрированных маркетинговых коммуникаций является дуальность их природы: объединение каналов и средств продвижения, которые существует в реальной и в виртуальной экономике (благодаря интернет-пространству). Определены тенденции в развитии интегрированных маркетинговых коммуникаций. Для изучения влияния на формирование интегрированных маркетинговых коммуникаций определено 15 мотивов приобретения гелиоэнергетического оборудования (по преобразованию солнечной энергии) — в качестве конкретного примера продукта на рынке B2B. Наиболее значимые из них: цена покупки, доступность солнечной энергии, цена эксплуатации альтернативного товара, финансовые выгоды (налоговые льготы, зеленый тариф). Объективная структура мотивов покупки для B2B-потребителей на рекреационном, сельскохозяйственном и строительном сегментах в Украине создана на основе экспертных оценок. Тем не менее, существуют определенные барьеры на пути готовности потребителей экономить на нынешних и будущих переплатах за счет использования солнечной энергии. Разделение целевой аудитории на сферы B2B и B2C создает предпосылки для ранжирования важности различных маркетинговых мероприятий в рамках ИМК.

ИНТЕГРИРОВАННЫЕ МАРКЕТИНГОВЫЕ КОММУНИКАЦИИ; ПОВЕДЕНИЕ ПОТРЕБИТЕЛЕЙ НА РЫНКАХ B2B; МОТИВЫ ПРИОБРЕТЕНИЯ НА РЫНКЕ ПРОМЫШЛЕННОЙ ПРОДУКЦИИ; УКРАИНСКИЙ РЫНОК ГЕЛИОЭНЕРГЕТИЧЕСКОГО ОБОРУДОВАНИЯ.

Introduction, Market penetration requires a company to have connections, contacts and relationships both in the micro- and macro- marketing space, which is to say, establishing marketing communications and developing a communicative policy strategy is necessary.

Unorganized use of various tools of marketing communications, such as advertising, sponsorship, sales promotion, and PR-activities is inefficient for the company. The best influence on the consumer can be achieved through an integrated marketing communications coverage of the company's target audience. The ability to identify customer needs, to identify the motives for acquisition of goods or services, as well as to highlight features in the purchase decision is important for the understanding of consumer behavior. Marketers need to understand, explain and predict the desired behavior of the consumer. Knowledge of consumer behavior is a prerequisite for establishing effective marketing communications for any organization and has certain features in the industrial market. Thus, it is necessary to combine different forms of promotion into a single coherent program of integrated marketing communications.

Literature review. General questions of the theory and practice of marketing communications have received considerable attention in the works of foreign authors such as the following: A. Batre, J. Burnet, E. Blake, E. Bond, E. Dihtl, Kotler, F-F Lamb, K. Larson, J. Myers, S. Moriarty, L. Percy, J. R. Rossiter, William Wells, R. Fizdeyl, T. Harris. American (Robert Lauterborn, Stanley Tannenbaum and Don Schultz [1]) and English (Chris Barry, Alan Pulford, Paul Smith [2]) scientists have made the most significant contributions to the development and creation of integrated marketing communications paradigm, being the first to use a systematic approach in the development of policies to promote enterprises. Its essence is the integrated use of marketing communication tools to maximize the impact on the consumer. Features of integrated marketing communications were summarized by Pickton and Broderick and represented in the 4 C model, which includes the following elements [3]: Coherence; Consistency; Continuity; Complementary.

A.V. Arlantsev, E.N. Golubkov, N.I. Melentiev, A.V. Panko, E.V. Popov, A.A. Romanov, V.I. Cherenkov and F.I. Sharkov should be mentioned among the Russian authors studying this area of marketing communications.

Scientific studies of Ukrainian scientists as A.V. Voychak, S.M. Il'yashenko, T.I. Lukyanets,

A.F. Pavlenko, T.A. Primak, G.G. Pocheptsov and E.V. Romat werededicated to theoretical and practical problems of integrated brand communications, in particular components of the IMC, their organization and planning.

Authors such as Smith, Barry, and Pulford [4], Garkavenko [5], Sotnikov [6], and Romat [7] emphasize in their definitions that the IMC is a consistent activity in managing the company's promotion, and list its separate stages: planning, selection, implementation, analysis, etc. In our view, a disadvantage of a functional approach to the definition of the IMC is the shift in focus from the object and the subject of the IMC to the promotion process that reflects the essence of the IMC only partially.

In terms of defining the object of the IMC, Smith, Barry and Pulford [4], Kotler [8], Abrahamian [9], Romanov and Panko [10] Golubkov [11], and Romat [7] identify a combination and interaction of elements/resources/tools of communication within the marketing policy to promote the enterprise. At the same time, Smith [2], Burnett and Moriarty [12], Schultz, Tannenbaum and Lauterborn [1], Dowling [13], Sharkov [14], and Primak [15] emphasize that the combination of IMC encompasses not only forms of communication, but also elements of the marketing mix. In our opinion, defining the subject of the IMC in this manner corresponds to the modern trends of marketing activities, expanding the application prospects of IMC for enterprises.

We would particularly like to highlight the definition of the IMC by Stelmach [16], since it emphasizes that the scope of the IMC involves not only real but the Internet environment, and also points to the interactive nature of the IMC, which is a notable advantage of this concept of promotion.

In our opinion, one of the most fundamental views on the IMC has been expressed by Cherenkov, who in his work [17] considers the IMC as a stage in the development of the marketing theory, calling it a global integrated communication marketing whose era has lasted since the early 1990s up until the present time. The communicative component of the marketing mix (K-Mix) is central to modern marketing. The brand is the key to integrated marketing.

We have studied the theory and practice of the IMC in Ukraine in the industrial market. We have considered the modern theoretical directions and scientific schools in the problems of communication in industrial markets of innovative products, and provided the main provisions of the scientific and methodical approach to the formation of an integrated marketing communications program for the promotion of solar technologies by Ukranian [23].

Formation of the concept of integrated marketing communication (IMC)

The emergence of the concept of integrated marketing communications (IMC) in the 1990s has led to a revolution in the field of promotion, as much as the introduction of the concept of the marketing mix in the 1960s completely changed the practice of marketing [18]. While studying the literature dedicated to this issue, we have found that, in spite of the importance of integrated marketing communications, most of the works concentrated on the general theory of marketing communications or its components, such as public relations or advertising.

Integrated Marketing Communications is also called TTL-communications (from the English through-the-line).

All the definitions use the concepts of «association», «combination», «coordination», «interaction» in the same context of integration with respect to various means of communication. The differences lie in to the goals to which communication tools are used and in their structure.

Thus, to date, there is no single approach to the scientific definition of IMC. Analysis of multiple formulations revealed a trend in the development of the concept in the context of achieving the goals of the IMC as economic and social communication (Fig. 1).

In our opinion, it is necessary to focus on the triple purpose of the IMC, as it reflects their essence (Fig. 2). Achieving communication efficiency provides high-quality , transmission of information about the promoted object to the target audience with minimal losses [19]. The main criteria are to increase the efficiency of the communication of knowledge about the product (or brand or personality) when prompted and unprompted, increasing their fame, the purchase intent, as well as direct assistance in purchasing. Unfortunately, communication effectiveness is difficult to measure objectively, as to date there is no universal definition of the scale of human emotions. Having analyzed the available methodological approaches to communicative efficiency of the IMC complex, we can conclude that communication effectiveness is in the positive dynamics of communication effects caused by contact between the consumer and the IMC complex [7].

Achieving economic efficiency means that a company is receiving benefits in the form of profits as a result of introducing a set of IMC measures. Indicators such as sales growth, profitability, net income, net income, etc., can also serve as economic efficiency parameters. All these indicators can be expressed numerically, so there are many mathematical and economic instruments to measure them. The key factor is that the amount of money spent on implementing a set of IMC should be less than the inflow of net income to be received by the company from customers. The problem is that a high communication efficiency may be accompanied by low economic efficiency, which is often associated with delayed (spill-over) effect and the effect of depreciation, therefore, there is no definite answer about the economic effectiveness of the IMC complex.

Communication efficiency:	Economic efficiency:	Social efficiency:
· strengthening the positive image · clarity, consistency and maximizing the impact of communication programs; · brand positioning; · ensuring clarity, consistency and maximum communication impact; · promoting brands, services, or companies to support single positioning;	· achieving maximum economic efficiency; · getting added value provided by the general plan of IMC; · ensuring profit margins and market capitalization of the company;	· forming positive public opinion · ensuring maximum impact on the target audience; · forming stable long-term relationships with market participants and the strategic objectives of the enterprise; · establishing (bilateral) relations with the target audience.

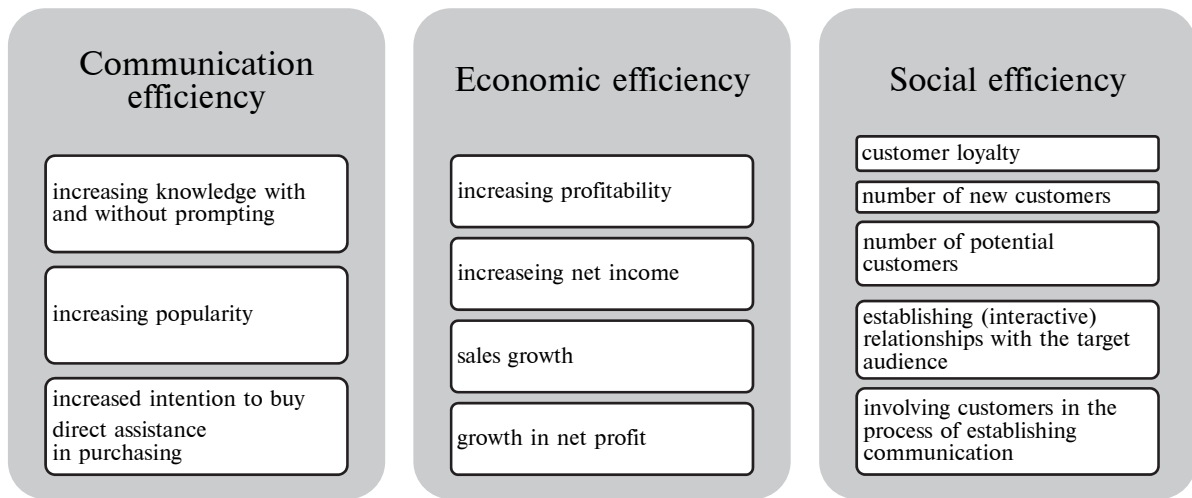**Fig. 1.** Objectives of integrated marketing communications

Fig. 2. Indicators of IMC efficiency depending on the objectives

Social benefits obtained by the company as a result of the IMC means achieving a sustainable dialogue with the target audience. Thus, we go beyond the usual boundaries of achieving customer loyalty by studying their national and cultural characteristics, social status and other indicators of consumer behavior, and attain a high level of consumer involvement into the process of interaction with the company. Online tools such as web portals, social networks, forums, chat rooms, live journals, mobile applications serve to implement interactive marketing communications. As a result, the firm receives information about the number of new and potential customers, as well as about the reactions of the target and other audiences to the influences exerted on them via the IMC. Consequently, marketers use a set of integrated marketing communications to prepare «communication on request» in order to better meet expectations and tastes of consumers.

To date, communication, e.g., round the clock customer support via remote access is a huge advantage when making purchasing decisions, particularly in the virtual space. Thus, the proportion of the use of certain traditional channels of communication is reduced due to the increase in the share of Internet communications. Social efficiency of the company's IMC can be measured by traditional sociometric and mediametric indicators and methods of analysis.

A feature of the integrated marketing communications is their binary nature: combining channels and means of promotion both in the real and in the virtual economy (on the Internet) [26]. Fig. 3 shows that the company can deploy marketing communications in both the real and the virtual space separately, independently and integrated in both areas (zone of intersection). The most common tools of marketing communication in a real environment are various types of advertising, public relations, sales promotion activities, personal selling, trade shows, direct marketing. The most relevant specific tools in the virtual environment are now search engine optimization (SEO), social media optimization (SMO), social media marketing (SMM), banner and contextual advertising, forums and webinars. Using parallel and integrated marketing communication tools involves developing the media mix. Using media of various types (TV, press, radio, outdoor advertising, Internet, etc.) within the same IMC program makes it possible to minimize marketing costs and increase the efficiency of the campaign to promote solar technology.
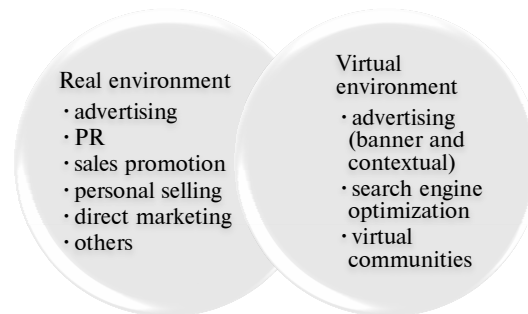

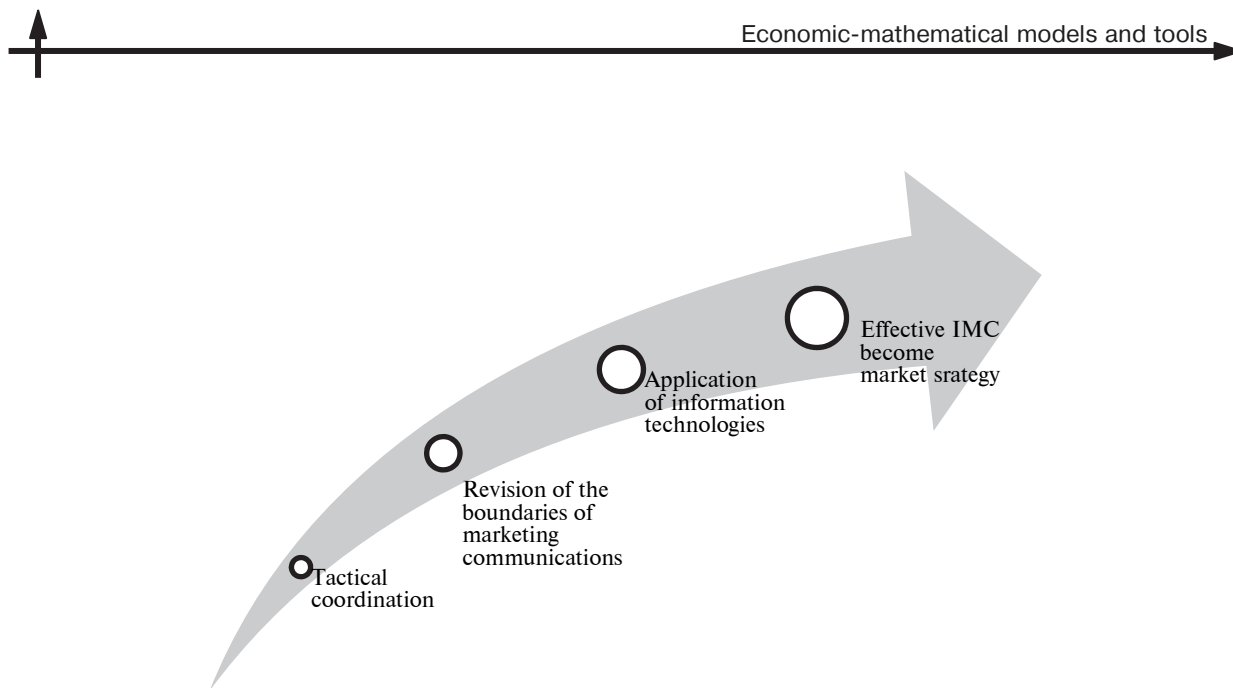**Fig. 3.** The binary nature of the IMC

Fig. 4. Historical stages of integration development of marketing communications

The greater the intersection of the marketing communication tools in the real and the virtual environments as part of the IMC, the greater the synergistic effect obtained by the company.

Based on the study, the authors propose the following definition:

Integrated Marketing Communications is a combination of coordinated marketing activities specific to the object of promotion used to achieve communication, economic and social efficiency of the company's marketing activity, combining the real and the virtual environments.

Unlike other definitions of IMC, this one takes into account any integration options of the marketing communication tools directly with each other (advertising, public relations agency, direct marketing, sales promotion), as well as with other components of the marketing mix (e.g., modernization of goods, pricing strategies, logistics schemes) and using specific online marketing tools.

Our definition of the IMC specifies the object of promotion, which may be a commodity, a trade mark, a brand, an identity, or a territory. IMC subjects, from our point of view, are the company about which potential customers should be informed, and the marketing specialist forming an IMC complex (who may be a representative of a third party or a part of the company's personnel).

Thus, the concept of the IMC has grown from a simple integration of communications that it implied in the early 1990s to the strategic integration of marketing communications. As a matter of fact, the IMC make up a part of the company's strategy. Its basis is orientation towards the customers, as well as an understanding that not only planned communication, but also any actions of the employees carry a certain message to the stakeholders [20].

So, initially the possibilities of communicating with the consumer have been greatly limited. To date, these opportunities are much wider, and the number of communication tools is growing.

The first level of communication integration in the company involves the cross-operation of various specialists for planning and consolidation in the communications field.

At the second level, new ideas for improving communications emerge. For example, the personnel can be used not only for distributing marketing communications, but also as a target of the communication. The role of internal marketing is increasing.

At the third level, using information technology solutions such as databases for registering customer transactions allows businesses to interact with specific consumer groups instead of the average individual.

The objectives of companies at the fourth level of integration change. At this stage, the skill and ability to evaluate investments in a particular group of customers becomes more important than evaluating the sales growth as a result of the

advertising campaign. It is also important to use marketing communications to perform organizational and strategic directives.

This approach corresponds to the fourth level of the IMC which is the highest. Communications can be integrated at different levels: strategic, tactical, the level of business processes, educational, and other. At this stage, companies need to continuously monitor and evaluate the effectiveness of marketing communications.

According to many researchers, most companies today are at stages I and II by their integration of marketing communications [20], i.e.:
− the marketing of the company is focused more on the product than on the consumer. The company's main efforts in managing marketing communications are spent on coordination. It should be noted that it is often not observed even the messages sent to users through various media channels are not coordinated;
− the company is actively trying to understand what consumers want to hear or see, as well as when, where and through which media channels they want to receive messages. At this stage, the integration of marketing communications is dictated primarily by the needs of existing and potential customers.

Integration stages I and II do not involve the IMC becoming part of the overall strategy. However, these stages require a minimum tactical coordination of the communications. In addition, their role in the enterprise and in the achievement of the enterprise's strategic goals must be apparent to senior managers. To do this, a system for monitoring the effectiveness of the communication strategy needs to be developed.

The existing practices often show that one of the main obstacles for integration of marketing communications are poorly established communications between departments within the company. Departments often do not work cohesively in pursuit of their own goals, which complicates the process.

Organizational integration of the enterprise exists only to the extent that it is possible to provide a continuous exchange of information among its structural units [12] and their interaction in order to achieve common goals.

It should be noted that market development depends largely on the buyers with the increasing role of information technology among consumers. Because of the unpredictability of consumer behavior, growing social problems in the society and increasing individualism, in most cases, the results of market research are losing their predicting effectiveness. Interactive means of disseminating information have to be used in order to achieve the most effective response to the demands of consumers, which leads to a new way of functioning of marketing communications.

Current market conditions and the level of development of information technologies determine the further development of the IMC theory. Modern research in this area, in particular, by Ulyanovskiy and Popov, are largely dedicated to the influence of globalization and the development of social consciousness in the IMC [21, 22].

Angus Deaton, awarded the nobel memorial prize in economic sciences in 2015, analyzes in his works the behavior patterns of consumers, questions of poverty and well-being of the population at the micro level. The public is interested in Deaton's research on how individual consumers make choices. The importance of this issue is manifested in the marketing activities of companies, as well as in the economic policy in general.

Thus, studying the behavior of customers makes it necessary to identify the motives, i.e.,the reasons, preconditions, inducing certain actions that accompany the purchase. Information about the behavior of the company's consumer is crucial for developing an integrated marketing communications program, as it allows to choose the optimal combination of resources and communication channels, as well as their sources and carriers.

To develop the effective targeted program for the IMC of companies in the market of solar power equipment in Ukraine, ensuring the development of renewable solar energy sales, the specific factors of the behavior of Ukrainian consumers need to be taken into account. A key issue in the marketing activities of these enterprises is to identify the motives of consumers willing to voluntarily pay more for the energy produced directly from the sun. It should be emphasized that behavioral motives are somewhat different for different segments of the consumers of solar power equipment. We made an attempt to rank these motives for the existing customers in the market segments we identified through our marketing study (Tab. 1) [23].

Behavioral motives for purchasing solar energy conversion equipment.
(compiled by the authors from the materialsof Refs. [25, 26])

№	Motives	Description
1	Cost of operating an alternative product	Price and availability of existing alternatives to solar energy. Alternatives are usually electricity or energy derived from fossil fuels (natural gas, oil, coal). Corresponds to the rates and the cost of the environmental damage caused.
2	Availability of solar energy	Is the resource available in the location under consideration? Corresponds to the number of sunny days and the power of insolation in a particular location. A relative quantity. This factor is considered in the assessment of market capacity.
3	Convenience	How hard and difficult is it to use solar stations?
4	Consumption culture	Directly related to environmental protection. Social impacts of solar power equipment depend on geographical conditions, political situation, and mentality.
5	Social responsibility	The ability to not only understand that solar energy can provide physical benefits (long or short), but also consider the full benefits of economies of scale resulting from collective use.
6	Efficiency of solar conversion systems	If the efficiency (COP) of the solar station increases, the number of parts of the installation and/or the size (area) of the installation shall be reduced. Value depends primarily on the physical and technical characteristics of the solar system and can vary from 30 to 70%.
7	Protecting the environment	Long-term benefits for the environment are in avoiding the use of fossil fuels and using solar energy instead to meet the challenges of global climate change, ozone depletion, deterioration of health and quality of life of the planet.
8	Awareness	Understanding that solar energy is available and can be used in household and industrial purposes. Usually achieved through advertising. Effective use of social advocacy communication channels.
9	Price of purchasing	The cost of solar energy for the consumer, taking into account the fiscal benefits (if provided by the government).
10	Research funding	The scale of financial contributions for studying «solar technology». Depends on the state budget policy and therefore the relevance of the application in a given country. Funding for research may lead to lower prices on converted solar energy and increase the efficiency of solar stations.
11	Risk	Are tax incentives and long-term benefits (savings) guaranteed? How often are such rules revised by the government? Guaranteed market for solar energy, the initial price of which is supported artificially, to be built by the government to promote investment.
12	Financial benefits (savings)	Financial benefits from the use of solar energy through solar power plants that are not included in the price. Includes tax credits, annual tax breaks, reimbursement of the cost of environmental damage, the cost of traditional energy sources which is not used (preserved) through the use of solar energy.
13	Stable economy	Benefits of reducing the dependence on imported energy and the formation of a self-sufficient, independent energy economy.
14	Appearance	Aesthetic component of solar power equipment.
15	Changes in price	The price of a solar station can decrease as well as increase. In the absence of price fluctuations in the case of steadily rising tax benefits, it is possible to achieve maximum savings.

**The significance of individual motifs for purchasing solar energy conversion equipment
for different segments of consumers in Ukraine**
(compiled by the authors based on expert judgment [25])

№	Motive	Significance (weight in points − on a scale from 0 to 100%)				
		Recreational complex	Agricultural sector	Building	Social services	Private consumers
1	Cost of operating an alternative product	10	10	10	15	15
2	Availability of solar energy	20	20	20	20	20
3	Convenience	0	0	0	0	5
4	Consumption culture	0	0	0	2	2
5	Social responsibility	5	5	5	3	3
6	Efficiency of solar conversion systems	7	7	7	5	5
7	Protecting the environment	0	0	0	0	5
8	Awareness	3	3	3	5	5
9	Price of purchasing	25	25	25	25	25
10	Research funding	0	0	5	5	0
11	Risk	5	5	5		
12	Financial benefits (savings)	15	15	15	10	10
13	Stable economy	0	10	0	10	0
14	Appearance	5	0	0	0	5
15	Changes in price	5	0	5	0	0
	Total points	100	100	100	100	100

Tab. 1 shows 15 motives of consumer behavior in the market of solar power equipment in Ukraine. These reasons can be divided into three groups according to their functional value for the customer: economic (the cost of operating an alternative product, efficiency of solar conversion systems, price, financial benefits (savings), changes in price); social (availability of solar energy, consumption culture, social responsibility, protecting the environment, awareness, risk, stable economy), aesthetic (convenience, appearance). Studying these consumption motives directly in the market segments will allow tofind an individual approach to the construction of the IMC program for each client. Thus, at present the market of Ukrainian solar power equipment enterprises should focus primarily on the following consumer segments when forming the IMC complex:

1. Recreational complex, i.e., enterprises of the recreational industry and catering;

2. Building, i.e., construction companies involved in the construction of luxury housing;

3. Agricultural sector;

4. Social services;

5. Private consumers, i.e., owners of private residences with above-average incomes.

We propose a structure of the motives for each of the customer segments in Ukraine based on the method of expert evaluations (Tab. 2).

It is logical that different customer segments are characterized by some combination of the motives for purchase. However, despite the significant difference between the individual segments, some general trends can be traced. For example, the most significant (10 to 25%) motives for acquisition absolutely for all target groups of consumers in Ukraine are the following:

1. Price.

2. Availability of solar energy.

3. Cost of operating an alternative product.

4. Financial benefits (savings).

You can also trace some similarity in the distribution structure of motives between the recreational, agricultural and building segments (Tab. 3).

Comparative characteristics of different customer segments based on the purchase of solar energy conversion equipment in Ukraine [25]

№	Differences	B2B Market	B2C market
1	Segments	1. Recreational Complex 2. Agricultural sector 3. Building	1. Social services 2. Private customers
2	Purpose	Commercial	Household
3	Motives of purchasing	1. Price (25 %) 2. Availability of solar energy (20 %) 3. Financial benefits (15 %) 4. Cost of operating an alternative product (10 %) 5. Efficiency of solar energy conversion equipment (7 %) 6. Risk (5 %)/Social responsibility (5 %)	1. Price (25 %) 2. Availability of solar energy (20 %) 3. Cost of operating an alternative product (15 %) 4. Financial benefits (10 %) 5. Awareness (5 %) / Efficiency of solar energy conversion equipment (5 %) 6. Social responsibility (5 %)

This is not surprising, because all of these consumers are enterprises governed by the market trends for B2B organizations. The «business to business» segment corresponds to more organized markets where a certain number of contractors are operating under the terms agreed between them. In this case, market transparency is key to engaging in business activities of clean environmentally friendly energy. If the company is committed to corporate responsibility, the brand with «green» energy can make it reliable in the eyes of consumers. Compared to individual consumers, they are less affected by tariffs, and more by the material components, for example, the size of the savings, efficiency of the solar station (which is proportional to the price of the solar energy converted), risks, possible price changes. The use of innovative «solar» technologies demands something more than simple awareness from a company; the solar energy equipment must be installed reasonably based on investment and financial performance.

There is also some similarity to be observed in the structure of the motives of individual private consumers and the social sphere (Tab. 3). This can probably be attributed to the large influence of social factors: consumer of these segments use solar energy for domestic and not commercial purposes. Unlike other segments, their important motives include consumption culture, convenience, environmental protection, which is also associated with the direct psychological impact on the person using the solar thermal system. A combination of both rational motives, and intangible assets (for example, brand «reputation», which plays an important role in consumer decisions) is typical for the segment of individual customers (retail market). The factor of brand reputation is the most sensitive to marketing influences for retail customers.

However, when it comes to the acquisition of solar power plants in the Ukranian market, there are, unfortunately, certain barriers to the willingness of consumers to current overpayments and future savings through using solar energy which must be taken into account in the formation of the IMC. The main factors hindering the development of the solar energy market include [27]:
− Lack of confidence in the system,
− Conservative preference of the consumers
− Lack of free applications for the consumer.

Marketing tools such as the IMC can be effectively used to overcome these barriers, e.g., by introducing the so-called «green» mandates, branding (creating strong brands) and joint communications with «green» brands such as Greenpeace and the World Wildlife Fund. The abundance of brands on a small market leads to confusion rather than transparency, and reduces consumer confidence. Overcoming the conservatism barrier requires certain small 'sacrifices' from the average consumer, and is achieved by small increases in price and by high

quality of services, correctly created and implemented by the IMC. This implies that the sellers of solar installations must first and foremost understand the preferences of the potential buyers, and only then form pricing and communications. Free extras (calendars, coupons, discounts, and similar tools) demonstrate the transparency of the market and allow consumers to see exactly what they are investing in.

We have had the opportunity to test our own software developed for integrated marketing communications with enterprise-level customers at the state-run STANKOSERT science and technology center, with the goal of promoting solar technology. We have revealed potential customers from the existing customers of STANKOSERT.

Target audience (customers) are Ukrainian enterprises with high energy consumption, in need of updating their heat-supply equipment. The IMC program should be oriented at the target audience of STANKOSERT's consumers who are interested in buying solar technology to reduce the level of costs for traditional energy. Thus, the financial benefits, the efficiency of the solar equipment, reduced risks, and protection of the environment are the primary motivation for the acquisition of this equipment. Therefore, the type of consumption in these solar installations iscommercial use in the B2B market. The choice of marketing communications tools included in the list of the IMC program was due to the engagement level of STANKOSERT's consumers regarding solar technology specifications.

Taking into account the above features of the potential buyers, we have selected the following elements of the media mix (Fig. 5):

- • Direct marketing:
- − personal sales;
- − mailing lists;
- − introduction of CRM-system;
- • Public relations:
- − conferences;
- − workshops;
- − publications;
- − TV broadcasts;
- − social projects;
- • Exhibitions:
- − industrial
- − specialized;
- • Outdoor advertising:
- − branding billboards;
- − street TV;
- − branding posters;
- • TV commercial:
- − specialized business channels;
- − Odessa's regional channels;
- • Internet communication:
- − Support and optimization;
- − Contextual advertising;
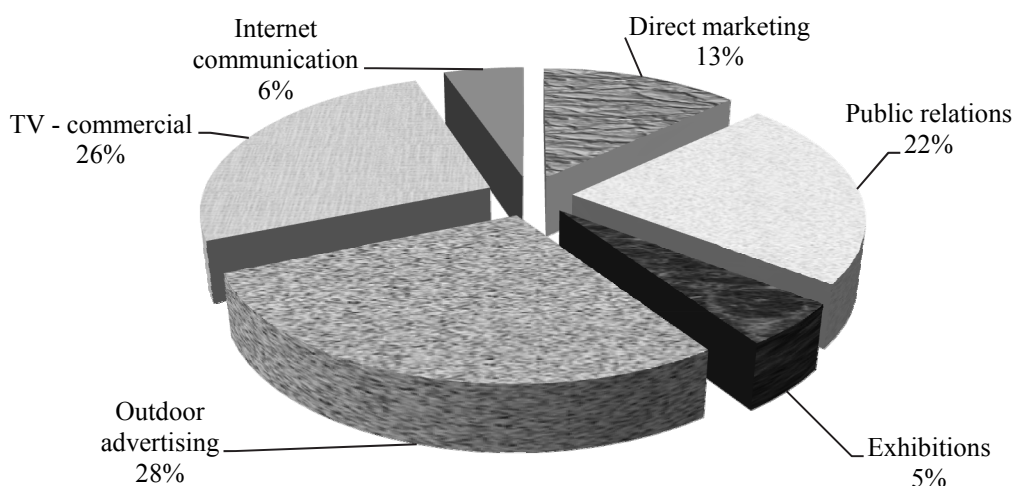- − Participation in the discussion forums.

Fig. 5. Shares of various marketing communications in the budget of the IMC program for STANKOSERT [25]

The relevance of implementing the complex of integrated marketing communications is due to several reasons:

· The reduction in the effectiveness of certain tools of the marketing communication policy, including due to high costs (for example, television advertising). Using the IMC complex allows to combine the budgets needed to promote a product via different channels of communication, reducing the cost for each of themThis way the company can achieve its aim effectively, as well as deal with fewer partners, delegating to them unified groups of complex solutions.

· The rapid growth of the information flow and the marketing communications technologies under the influence of the Internet. The emergence of new distribution channels, interactive media, the development of specialized media requires making adjustments and selecting different priorities in the company's strategy of marketing communications.

· The growing individualization of consumption and, consequently, a transition to two-way interactive marketing communications require involving both the consumer and the producer. In such circumstances, hard-to-control sources of influence and information dissemination (independent media, community social networks, business partners, family and friends, experts, state and public organizations, monitoring the quality of products) have started to play an increasingly important role to play.

· Oversaturation of the market with similar services and goods produced in a highly competitive environment by identical technologies. Such a market situation is a challenge for the marketing specialists as they need to be creative in using new approaches and promotion technologies to position a particular product/service/brand in the minds of the target audience.

Generally, in our view, the following trends in the development of integrated marketing communications should be identified:

1) extended use of individual marketing strategies and marketing relationships within the IMC;

2) extended use of new tools of marketing communications, as well as their coordination on the Internet;

3) distribution of responsibility (outsourcing): transfer of the rights to manage the integrated marketing communications complex to an outside organization specializing in marketing;

4) orientation of coordinated communicative messages to several different audiences with sequential positioning of the product/service / brand;

5) using the advances in psychotechnologies including NLP for creating communication messages;

6) evaluating the effectiveness of the integrated marketing communications complex.

Communications can be integrated both at the strategic and tactical levels. At this stage the company needs to continuously monitor and evaluate the effectiveness of marketing communications.

Conclusions, Implications and Further Research

1. Studies have shown that there is no consensus on the definition of integrated marketing communications. We have identified the IMC, given the «integration» between the communication tools, the «integration» of the communication tools with other components of the marketing mix, «integration» of the communication tools in both areas of the company's activity − (in this case, the IMC arise in a new economic environment engendered by a combination of the real and virtual economies). We have taken into account and developed the three-component goal of the IMC: achieving communication, economic and social efficiency.

2. We have explored the historic stage of the integration of marketing communications andallocated 4 stages: tactical coordination, revision of the boundaries of marketing communications, using information technologies and proper integration of marketing communications into the company's strategy. Since the early 1990s, the concept of the IMC has evolved from simple communication integration to the level where the inclusion of the IMC is one of the basic elements of the business strategy.

3. The basis of the formation of the IMC is the focus on the target audience, with studying the motives of consumer behavior gaining a special importance. We carried out a marketing study of the companies selling solar energy

equipment in Ukraine, which resulted in identifying 5 demand segments: individual consumers (36%), recreation complex (28 %), agriculture (16 %), construction (12 %) and social sector (8 %). The motives for purchasing solar stations were revealed for these segments, the most important of them being the price, the availability of solar energy, alternative costs, and savings. The structure of such motives was determined individually for each segment.

4. In order to select specific marketing tools for promoting the solar technology via the IMC program between the selected segments of consumers, we identified differences in the usage goals and purchase motives. The obtained B2B and B2C market segments highlight the importance of ranking various marketing activities within the IMC.

Prospects for further research: Forming an effective IMC complex for enterprises depends on the specifics of the enterprise and the characteristics of the environment in which it operates, and the characteristics of the consumer to whom they are targeting their production. Marketing specialists have remarked upon the increase in business interest in the emergence of new business models based on the IMC, based on some form of consumer behavior at both the real and the virtual markets. Such models provide new opportunities for interaction with the customer and increase the company's competitiveness in the market.

REFERENCES

1.**Schultz D.E., Tannenbaum S., Lauterborn R.F.** The new paradigm of marketing. Integrable marketing communications. M.: Infra-M, 2004, p. 19−21. (rus)

2.**Smith P.** Marketing Communications. Integration achievements: a monograph. Moscow, 1993, pp. 30−31. (rus)

3.**Pickton D., Broderick A.** Integrated Marketing Communications. Financial Times Pearson Education Limited, 2005. 650 p.

4.**Paul Smith, Chris Barry, Alan Pulford.** Communications Strategic Marketing». Trans. from English. Ed. prof. LF Nikulin. Moscow, Unity-Dana, 2001. 415 p. (rus)

5.**Garkavenko S.S.** Marketing. Pidruchnik. Kiev: Libra, 2004. 712 p.

6.**Sotnikov E.A., Zykov M.E.** Integrated marketing communications as a competitive advantage of the company. *Bulletin OryolGIET*, 2009, no. 1-1 (7), pp. 125−133. (rus)

7.**Romat E.V., Senderov D.V.** Advertising. Practical Theory. 9th ed. St. Petersburg, Peter, 2016. 554 p. (Series «Standard of third generation. Textbooks for schools»). (rus)

8.**Kotler.** Philippe Principles of Marketing. Trans. with angl. E. Solovyov. 4th ed. Moscow, Business Book, 1995. 702 p. (rus)

9.**Abrahamian E.** Promotion as a modern marketing communication. *Marketing Communications*, 2001, no. 3, p. 21. (rus)

10.**Romanov A.A., Panko A.V.** Marketing; Communications. Moscow, Eksmo, 2006. 432 p. (rus)

11.**Golubkova E.N.** Marketing Communications. Moscow, Finpress, 2003. 256 p. (rus)

12.**Burnet J., Moriarty S.** Marketing Communications: an integrated approach. Translated from English. Ed. S.G. Bozhuk. St. Petersburg, Peter, 2001. 864 p. (rus)

13.**Dowling G.** Reputation of the company: the creation, management, evaluation effectiveness: Trans. with angl. M.: IMAGE-Contact; Infra-M, 2003. 368 p. (rus)

14.**Sharkov F.I.** Integrated communications: advertising, public relations, branding: Textbook. (rus)

15.**Primak T.O.** Zmist ta znachennya integrovanih marketingovyh komunikatsiy: sinergichny efekt. *Problems of science*, 2002, no. 7, pp. 36−44.

16.**Stelmach A.A.** Interaktivni marketingovi komunikatsii in menedzhmenti pidpriemstva. Kiev: Reklamediya, 2010. 312 s. (rus)

17.**Cherenkov V.I.** The evolution of marketing theory and the transformation of the dominant paradigm of marketing. *Bulletin of St. Petersburg State University*, ser. 6, is. 2 (no. 16). (rus)

18.**Schultz D.** Integrated Marketing Communications. St. Petersburg, 2005. URL: http://cfin.ru/ free. Caps. with the title. Screen, p. 24.

19.**Gabidulin E.M., Pilipchuk N.I.** Lectures on Information Theory. Moscow, MIPT, 2007. 214 p.

20.**Blyde Jim.** Marketing communications: what? How? Why? Translated from English. Dnepropetrovsk, Balance Club, 2004. 368 p., p. 335.

21.**Ulyanovskiy A.** Marketing Communications: 28 tools millennium. Moscow, Eksmo, 2008. 432 p., pp. 24−25. (rus)

22.**Popov N.V.** Integrated marketing communications in the information society. *Biznesinform. Economy: Management and Marketing*, 2010, no. 4(3), pp. 58−69, 60−63. (rus)

23.**Litovchenko I.L., Shkurupskaya I.O.** Integrated marketing communications in solar energy conversion equipment market. Monograph. Kiev, Naukova Dumka, 2015. 211 p. (rus)

24.Advanced Modeling of Renewable Energy Market Dynamics: M. Evans, R. Little, K. Lloyd, G. Malikov, and G. Passolt, D. Arent, B. Swezey, and G. Mosey ‒ report Operated for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy by Midwest Research Institute, 2007.

25.Renewable Energy Policiesand Market Developments: A.L. van Dijk, L.W.M. Beurskens, M.G. Boots, M.B.T. Kaal, T.J. deLange, E.J.W. van Sambeek, M.A. Uyterlinde ‒ report of projec tunder the programme 'Energy, Environment and Sustainable Development' ‒ TheREMAC 2014.

26.**Litovchenko I.L.** Marketing v usloviiakh dual'nosti sovremennogo promyshlennogo rynka. *Naukovii visnik Khersons'kogo derzhavnogo universitetu. Seriia: Ekonomichni nauki.* 2015. № 10. Ch. 3. S. 60‒63.

СПИСОК ЛИТЕРАТУРЫ

1. **Шульц Д.Е., Танненбаум С.И., Лаутерборн Р.Ф.** Новая парадигма маркетинга. Интегрируемые маркетинговые коммуникации, М.: Инфра-М, 2004. С. 19‒21.

2. **Смит П.** Маркетинговые коммуникации. Интеграционные достижения: моногр. М., 1993. С. 30‒31/

3. **Pickton D., Broderick A.** Integrated Marketing Communications. Financial Times Pearson Education Limited, 2005. 650 p.

4. **Пол Смит, Крис Бэрри, Алан Пулфорд.** «Коммуникации стратегического маркетинга» : пер. с англ. / под ред. проф. Л.Ф. Никулина. М.: Юнити-Дана, 2001. 415 с.

5. **Гаркавенко С.С.** Маркетинг. Підручник. Київ: Лібра, 2004. 712 с.

6. **Сотникова Е.А., Зыкова М.Е.** Интегрированные маркетинговые коммуникации как конкурентное преимущество компании // Вестник ОрёлГИЭТ. 2009. № 1-1(7). С. 125‒133.

7. **Ромат Е.В., Сендеров Д.В.** Реклама. Практическая теория. 9-е изд. СПб.: Питер, 2016. 544 с. (Серия «Стандарт третьего поколения. Учебники для вузов»).

8. **Котлер Ф.** Основы маркетинга / пер. с англ. Е. Соловьева. 4-е изд. М.: Бизнес-Книга, 1995. 702 с

9. **Абрамян Э.** Promotion как современная маркетинговая коммуникация // Маркетинговые коммуникации. 2001. № 3. С. 21.

10. **Романов А.А., Панько А.В.** Маркетинговые; коммуникации. М.: Эксмо, 2006. 432 с.

11. **Голубкова Е.Н.** Маркетинговые коммуникации. М.: Финпресс, 2003. 256 с.

12. **Бернет Дж., Мориарти С.** Маркетинговые коммуникации: интегрированный подход : пер. с англ. / под ред. С.Г. Божук. СПб.: Питер, 2001. 864 с.

13. **Даулинг Г.** Репутация фирмы: создание, управление, оценка эффективности: пер. с англ. М.: ИМИДЖ-Контакт; Инфра-М, 2003. С. 368

14. **Шарков Ф.И.** Интегрированные коммуникации: реклама, паблик рилейшнз, брендинг: учеб. пособие.

15. **Примак Т.О.** Маркетингові комунікації в систем і управління ринковою діяльністю підприємства.

16. **Стельмах А.А.** Интерактивные маркетинговые коммуникации в менеджменте предприятия. Киев: Рекламедия, 2010. 312 с.

17. **Черенков В.И.** Эволюция маркетинговой теории и трансформации доминирующей парадигмы маркетинга // Вестник СПб университета. Сер. 6 Вып. 2 (№ 16).

18. **Шульц Д.** Интегрированные маркетинговые коммуникации. СПб., 2005. URL: http://cfin.ru/ свободный. Загл. с титул. Экрана. С. 24.

19. **Габидулин Э.М., Пилипчук, Н.И.** Лекции по теории информации. М.: МФТИ, 2007. 214 с.

20. **Блайд Джим.** Маркетинговые коммуникации: что? как? почему? Пер. с англ. Днепропетровск: Баланс-Клуб, 2004. 368 с.

21. **Ульяновский А.** Маркетинговые коммуникации: 28 инструментов миллениума. М.: Эксмо, 2008. С. 24‒25.

22. **Попова Н.В.** Интегрированные маркетинговые коммуникации в условиях информатизации общества // Бизнесинформ. Экономика: Менеджмент и маркетинг. 2010. № 4(3). С. 58‒69, 60‒63.

23. **Литовченко И.Л. Шкурупская И.А.** Интегрированные маркетинговые коммуникации предприятий на рынке гелиоэнергетического оборудования: моногр.. Київ: Наукова думка, 2015. 211 с.

24. Advanced Modeling of Renewable Energy Market Dynamics: M. Evans, R. Little, K. Lloyd, G. Malikov, and G. Passolt, D. Arent, B. Swezey, and G. Mosey ‒ report Operated for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy by Midwest Research Institute, 2007.

25. Renewable Energy Policies and Market De-

velopments: A.L. vanDijk, L.W.M. Beurskens, M.G. Boots, M.B.T. Kaal, T.J. deLange, E.J.W. van Sambeek, M.A. Uyterlinde — report of project under the programme 'Energy, Environment and Sustainable Development' — TheREMAC 2014.

26. **Литовченко И.Л.** Маркетинг в условиях дуальности современного промышленного рынка // Науковий вісник Херсонського державного університету. Серія: Економічні науки. 2015. № 10. Ч. 3. С. 60—63.

SHKURUPSKAYA Irina A. — Marketing department, Odessa National Economic University.

65082. Preobrazhenskaya str. 8. Odessa. Ukraine. E-mail: irina.shkurupskaya@gmail.com

ШКУРУПСКАЯ Ирина Александровна — преподаватель кафедры «Маркетинг» Одесского национального экономического университета, кандидат экономических наук.

65082, ул. Преображенская, д. 8, г. Одесса, Украина. Тел.: +380674830163. E-mail: irina.shkurupskaya@gmail.com

LITOVCHENKO Irina L. — Odessa national economic university.

65082. Preobrazhenskaya str. 8. Odessa. Ukraine. E-mail: E-mail: irinatigrovna@mail.ru

ЛИТОВЧЕНКО Ирина Львовна — заведующий кафедры «Маркетинг» Одесского национального экономического университета, доктор экономических наук.

65082, ул. Преображенская, д. 8, г. Одесса, Украина. Тел.: +380677951556. E-mail: irinatigrovna@mail.ru

N.A. Kremlyova, A.A. Borisov, A.A. Frolov

A CREATIVE MODEL FOR GRAPHICAL DESIGN OF CONVERSION PROCESSES IN ENGINEERING BUSINESS

Н.А. Кремлёва, А.А. Борисов, А.А. Фролов

КРЕАТИВНАЯ МОДЕЛЬ ГРАФИЧЕСКОГО ПРОЕКТИРОВАНИЯ ПРОЦЕССОВ КОНВЕРСИИ В ИНЖЕНЕРНОМ БИЗНЕСЕ

Innovation processes are a tool for quantitative and qualitative assessment and subsequent improvement of the efficiency of the engineering business. To accomplish this task, we have developed a creative graphical model based on the principle of converting the manufacturing capital into its money equivalent in the form of sales volume. The graphical interpretation of the closed operating cycle of conversion (OCC) in a manufacturing-technological system (MTS) is implemented in a triangle coordinate system including five cash flow vectors: sales volume; manufacturing capital; technological costs; net income; main funds (sum of tangible and intangible assets). The theoretical principles and the architecture of the parameters of the engineering business have been formulated on the basis of examining the OCC parametrical equation in a triangle coordinate system. We have obtained the following results: in a real engineering business the conversion criterion of an operating cycle (the relation of sales volume to manufacturing capital) is less than unity; in an ideal operating cycle this criterion is equal to unity, and exceeds unity in excise business. Accordingly, the net income in a real operating cycle is less than the technological costs, and they are equal in an ideal operating cycle, and the net income is more than the technological costs in excise business. The main funds of a manufacturing-technological system in a real operating cycle are more than the net income, they are equal in an ideal cycle, and the main funds of an MTS are less than the net income in excise engineering business. The task of innovating projects is to create the architecture for the parameters of operation cycle conversion in an MTS providing an increase in the investment attractiveness of engineering business on the stock market.

CONVERTING MANUFACTURING CAPITAL; CLOSED OPERATING CYCLE; CONVERSION CRITERION; CAPITALIZATION OF TECHNOLOGICAL COSTS; MAIN FUNDS MANUFACTURING TECHNOLOGICAL SYSTEM OF ENGINEERING BUSINESS.

Инновационные процессы являются инструментом количественной и качественной оценки эффективности инженерного бизнеса и последующего совершенствования его эффективности. Для реализации этой задачи разработана проектно-графическая модель, в основу которой положен принцип конверсии производственного капитала в его денежный эквивалент в форме проданной продукции. Графическая интерпретация замкнутого операционного цикла конверсии (ОЦК) в производственно-технологической системе (ПТС) реализована в треугольной системе координат из пяти векторов денежных потоков: объема реализации продукции, производственного капитала, технологических затрат, чистого дохода, основных фондов (суммы материальных и нематериальных активов). На основе исследования параметрического уравнения ОЦК в треугольной системе координат сформулированы теоретические положения и архитектура параметров инженерного бизнеса. Получены следующие результаты: в реальном инженерном бизнесе критерий конверсии операционного цикла (отношение объема реализованной продукции к производственному капиталу) меньше единицы; в идеальном операционном цикле этот критерий равен единице; в акцизном бизнесе он больше единицы. Соответственно в реальном операционном цикле чистый доход меньше технологических затрат, в идеальном цикле они равны, а в акцизном бизнесе чистый доход больше технологических затрат. В реальном операционном цикле основные фонды производственно-технологической системы больше чистого дохода, в идеальном цикле они равны, а в акцизном инженерном бизнесе основные фонды ПТС меньше чистого дохода. Задачами инновационных проектов является создание архитектуры параметров операционного цикла конверсии в ПТС, обеспечивающей инвестиционную привлекательность инженерного бизнеса на фондовом рынке.

КОНВЕРСИЯ ПРОИЗВОДСТВЕННОГО КАПИТАЛА; ЗАКРЫТЫЙ ОПЕРАЦИОННЫЙ ЦИКЛ; КРИТЕРИЙ КОНВЕРСИИ; КАПИТАЛИЗАЦИЯ ТЕХНОЛОГИЧЕСКИХ ЗАТРАТ; ОСНОВНЫЕ ФОНДЫ ПРОИЗВОДСТВЕННО-ТЕХНОЛОГИЧЕСКОЙ СИСТЕМЫ ИНЖЕНЕРНОГО БИЗНЕСА.

Goal and objectives. Monetary flows in a closed operating cycle of an engineering business consisting of an integrated set of operational and technological processes as a result of conversion are formed as the sales volume of products. Therefore, the manufacturing performance of an

OCC can be improved by continuously implementing innovative projects ensuring the growth of the conversion level. The conversion level is equal to the relation of the manufacturing capital to monetary capital of an enterprise received from the sold products. To implement this task in engineering enterprises, management accounting is improved based on the market structure operating as a transfer of technological costs and consumer properties of products within technological stages that are also viewed in this case as zones of financial responsibility.

Our task was to develop practical recommendations for mastering the method of graphical design of an operating cycle of conversion (OCC) in manufacturing and technological systems of engineering business.

Introduction to the theory and practice of operating cycles of conversion. Business is one of the important creative areas of human practices aimed at helping people sustain their activities [1].

The supply in engineering business determines the consumer properties of products and services in the innovative market economy. Therefore, engineering business continuously solves creative innovative tasks: what to produce and how to produce it (what manufacturing capital and technology to use) so that products and services have competitive advantages on the market and on this basis to get the biggest sales volume at the lowest technological costs and the highest income.

Many creative projects in music, visual arts, and chess, economic, technological, mathematical projects and modeling, as well as other kinds of creative activities using electronic digital systems complement the creative activity of humans, performing ordinary multivariate tasks.

The engineering business is an integrated set of manufacturing and technological systems [2] that converts manufacturing capital into its cash equivalent in the form of sales volume of products and net income necessary and sufficient for continuous investment of simple and extended reproduction of the main funds of the manufacturing capital and for paying dividends to business owners in the amount of the remaining net income.

Therefore, the economic benefits of each MTS of an engineering businessis characterized by the sales volume V_{sv}, rub./year, at adequate cost Q, rub./year of the manufacturing capital.

The concept of adequacy implies the possibility and capability of the manufacturing capital to yield products with competitive advantages and in the amount needed on the market.

For this purpose, the production system of the engineering business should be organized and implemented based on the transfer of technological costs $G_0 W_0$, rub./year, and consumer properties (market value) of products within technological stages. Only in this case, the end products will have competitive advantages and will be sold at a price equal to or above its market value [3].

In addition, each manufacturing and technological system (MTS) is a zone of financial responsibility (ZFR) including a minimal integrated set of tangible and intangible assets and manufacturing (outputting) technological stages or end products with a market cost.

The sales volume should cover the sum of technological costs $G_0 W_0$, rub./year, (where G_0 is the volume of manufactured products in natural parameters, for example, units/year; and in this case, unit costs W_0, rub./units) and should provide a net income D_0, rub./year, including the annual depreciation (amortization) of tangible assets C_{ta}, rub./year, the annual amortization of intangible assets C_{ia}, rub./year, and the net operation profit P_0, rub./year.

This fact may be interpreted in this mathematical form:

$$\frac{V_{sv}}{G_0 W_0 + D_0} = \frac{V_{sv}}{G_0 W_0 + C_{ta} + C_{ia} + P_0} = 1. \quad (1)$$

Our research has shown [4−6] that the technological costs in the engineering business are, from the mathematical point of view, a parabola having the form:

$$W = aG^2 + bG + c, \quad (2)$$

where the constant coefficients a, b, c are constants of this manufacturing and technological system with the coordinates of the extremum (calculated parameters) $G_0 = -b/2a$; $W_0 = (4ac - b^2)/4a$.

Each coefficient of equation (2) determines the curvature of the parabola, and, consequently, the physical basis of a technological process. Therefore, to reduce technological costs, it is necessary to change the technology.
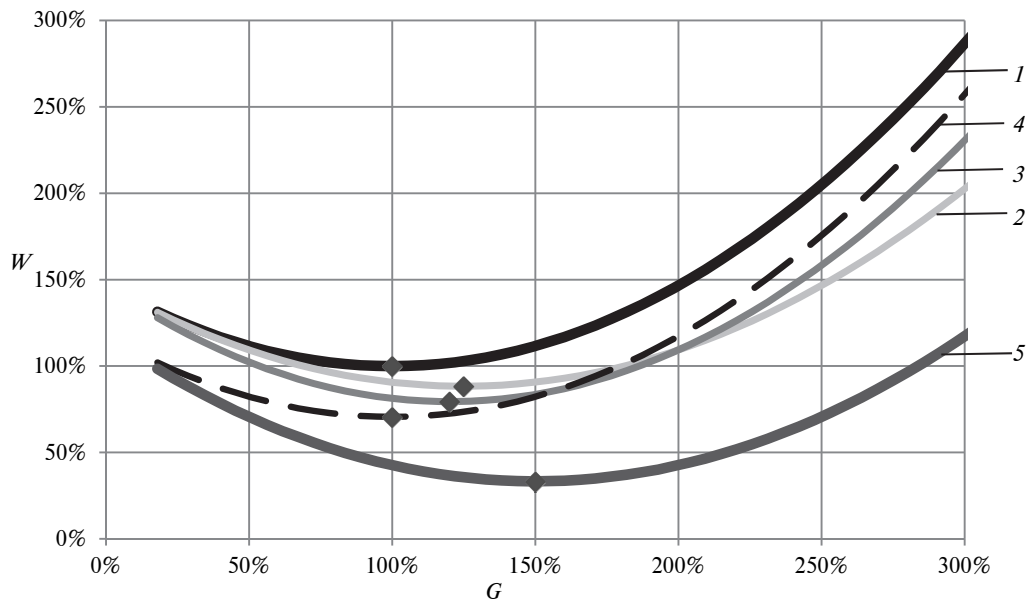
Fig. 1. Graphical interpretation of the mathematical model of technological costs
in the OCC of the manufacturing capital

For example, the parabolic dependence of unit costs on manufactured and sold products of an engineering enterprise has the form [7, 8]:

$$W = 3.28 \cdot 10^{-5}G^2 - 0.12G + 345.18,$$

where the extreme points are $G_0 = 0.12/2 \times 3.28 \cdot 10^{-5} = 1829$ units/year; $W_0 = (4 \times 3.28 \cdot 10^{-5} \cdot 345.18 - 0.12^2)/4 \cdot 3.28 \cdot 10^{-5} = 235$ rub. thousands/unit.

Fig. 1 presents an initial basic parabola and three parabolas made at values 20 % lower than one of the studied coefficients comparatively to its basic value (a is parabola 2; b is parabola 3 and c is parabola 4) and a resultant parabola made at lesser values of all coefficients by 20 % (parabola 5).

The greatest reduction of unit costs W takes place when there is a change in the value of coefficient C, determining the downward shift of the parabola. In this case, the coordinates of the extreme points are at 0 % on the G axis and at −29.32 % on the W axis, consequently, the range of production volume remains constant.

The smallest change of unit costs and the largest increase in the manufacturing volume is achieved when we change coefficient a, which defines the stretching or compression of the parabola along the vertical axis. In this case, the coordinates of the extreme points of the parabola change by 25 % on the G axis and by −11.66 %

on the W axis. The parabola moves to the right and down, and its branches grow along the vertical axis. In this case, the change in the manufacturing volume of products has a lesser impact on the change of unit costs.

The case when the coefficient b is changed yields intermediary results for reducing the unit costs and increasing the manufacturing volumes. This changes the coordinates of the parabola's extremum by 20% on the G axis and by −20.51 % on the W axis, i. e. the parabola moves to the right and down.

Simultaneously decreasing the values of all coefficients is optimal with respect to expanding the ranges of the manufacturing volume and of the reduction of unit costs. The extremum then shifts by 50 % on the G axis and by −66.62 % on the W axis.

Innovative technology may be designed on the basis of the parabola curvature required for a conversion process.

For example, instead of turning processing (blade processing) with a low material utilization ratio, it might be more effective to use hot or cold stamping, pressing, forging, hot rolling, cold rolling, powder metallurgy with high metal utilization rates.

In this sense the parabola is a creative mathematical model of technological costs in a manufacturing and technological system.

For the purposes of management accounting and designing innovating projects [9], the money equivalent of the manufacturing capital in each manufacturing-technological system Q, rub./year, should be estimated by the income approach. As a matter of fact, organizing production using the transfer of technological costs and values (consumer properties of products) within the technological stages that are zones of financial responsibility is done on the basis of internal management accounting [10, 11].

The manufacturing capital is equal to the sum of technological costs G_0W_0, rub./year, and the main funds of an enterprise U, rub./year, including fixed assets (tangible assets) U_{fa}, rub./year, taxable for entity property, and intangible assets U_{ia}, rub./year.

The mathematical dependence of this fact has the form:

$$\frac{Q}{G_0W_0 + U_{mf}} = \frac{Q}{G_0W_0 + U_{fa} + U_{ia}} = 1. \qquad (3)$$

We consider the engineering business as an integrated set of closed continuous OCC of the manufacturing capital Q into its cash equivalent in the form of the sales volume V_{sv}.

Consequently, to get the mathematical model of the conversion of manufacturing capital on the basis of a closed operating cycle, equation (1) should be equal to equation (3):

$$\frac{V_{sv}}{G_0W_0 + D_0} = \frac{Q}{G_0W_0 + U_{mf}}. \qquad (4)$$

A parametrical equation of converting the manufacturing capital has the form:

$$\frac{V_{sv}}{Q} = \frac{G_0W_0 + D_0}{G_0W_0 + U_{mf}}. \qquad (5)$$

This equation (5) has the following dimensionless form:

$$\frac{V_{sv}}{Q} = \frac{\dfrac{V_{sv}}{G_0W_0}}{\dfrac{Q}{G_0W_0}} = \frac{\dfrac{G_0W_0}{U_{mf}} + \dfrac{D_0}{U_{mf}}}{\dfrac{G_0U_0}{U_{mf}} + 1}. \qquad (6)$$

Our research shows [2, 3, 5] that the conversion level ϑ of manufacturing capital in the operating cycle is equal to the relation of the sales volume V_{sv} to the manufacturing capital Q.

If the level of converting the manufacturing capital in one operating cycle is equal to another operating cycle, in this case, both engineering businesses are similar (equivalent). Consequently, the conversion level is the conversion criterion and all dimensionless complexes in equation (6) are the conversion criteria of the manufacturing capital in the operating cycle of the engineering business.

Namely,

$\vartheta = \dfrac{V_{sv}}{Q}$, the conversion criterion is equal to a ratio of sales volume to manufacturing capital of the engineering business;

$\lambda = \dfrac{V_{sv}}{G_0W_0}$, the capitalization criterion is equal to a ratio of sales volume to technological costs of the operating cycle;

$\rho = \dfrac{Q}{G_0W_0}$, the resource criterion of manufacturing capital is equal to a ratio of manufacturing capital cost to technological costs;

$M = \dfrac{D_0}{U_{mf}}$, the investment criterion is equal to a ratio of net income to main funds;

$k_0 = \dfrac{G_0W_0}{U_{mf}}$, the characteristic of a manufacturing and technological system [5].

We will record the criteria equation (6) using the common notations of the dimensionless quantities:

$$\vartheta = \frac{\lambda}{\rho} = \frac{k_0 + M}{k_0 + 1}. \qquad (7)$$

The analysis of a conversion level in an operating cycle for three equivalent metallurgical enterprises manufacturing sheet rolling products is presented in Tab. 1 [2, 4−6]. The parameters of the investment attractiveness of enterprise are presented in the first part of Tab. 1. The calculated parameters of an operating cycle are presented in the second part; and finally, the conversion criteria are presented in the third part of Table.

Conversion parameters of manufacturing capital in operating cycles of equivalent metallurgical enterprises

Equivalent enterprises	JSC MMC	JSC NLMC	JSC Severstal
Stock market parameters for equivalent metallurgical enterprises that manufacture steels sheets, mln USD			
Sales volume, V_{sv}	5380.00	4468.73	5055.17
Return on sales, $r = P/V_{sv}$	24.6 %	41.6 %	35.2 %
Net profit, P_0	947.00	1385.34	1212.00
Operation profit, P	1323.48	1859.00	1779.42
Parameters of operation cycle			
Operation costs $C_{oc} = V_{sv} - P$	4056.52	2609.74	3275.75
$\Delta P = P - P_0 = N_{fa} + N_p$	376.48	473.66	567.42
Tax operating profit $N_p = P_0\psi_p/(1 - \psi_p)$, $\psi_p = 0.2$	236.75	348.34	303.00
Tax fixed assets $N_{fa} = \Delta P - N_p$	139.73	125.32	264.42
Fixed assets $U_{fa} = N_{fa}/\psi_{fa}$, $\psi_{fa} = 0.02$	6986.50	6266.00	13221.00
Depreciation costs $C_{dc} = 0{,}03\,U_{fa}$	209.60	188.00	396.63
Direct technological costs $G_0W_0 = C_{oc} - C_{dc}$	3846.92	2421.74	2879.12
Net income $D_0 = P_0 + C_{dc}$	1156.60	1573.34	1608.63
Sales volume $V_{sv} = G_0W_0 + D_0$ V_{sv}/V'_{sv}	5003.52 (0.93)	3995.08 (0.89)	4487.75 (0.89)
Manufacturing capital $Q = G_0W_0 + U_{fa}$	10833.42	8687.74	16100.12
Criteria of operation cycle			
Capitalization criterion $\lambda = V_{sv}/G_0W_0$	1.30	1.55	1.56
Investment criterion $M = D_0/U$	0.17	0.25	0.12(0.25)
Resources criterion $\rho = Q/G_0W_0$	2.82	3.59	5.59
Characteristic of operation cycle $k_0 = G_0W_0/U$	0.55	0.39	0.22
Conversion criterion $\vartheta = \dfrac{V_{sv}}{Q} = \dfrac{\lambda}{\rho} = \dfrac{k_0 + M}{k_0 + 1}$	0.46	0.46	0.28 (0.46)
Cost of equity capital, A, 19.04.2006, mln USD	7892.94	13964.22	7452.80

S o u r c e. Taken from [12−14].

The data analysis in Tab. 1 shows that the level of conversion at the Novolipetsky and Magnitogorsky metallurgical enterprises equals 0.46. As for Severstal, the conversion criterion is almost twice less and is equal to 0.28. This is because the internal estimate of the fixed asset value has been overstated by 2 times.

Graphical interpretation of the manufacturing capital conversion in a closed operating cycle in a manufacturing and technological system. The **conversion** of the manufacturing capital Q in a manufacturing and technological system that is an integrated set of technological processes is achieved in a closed operating cycle for the purpose of capitalizing technological costs G_0W_0 in their monetary equivalent in the form of product sales volume V_{sv}, tax payment in all level budgets and net income D_0 necessary and sufficient for investing simple and expanded reproduction of the main funds U_{mf} and the formation of net profit P_0 in dividend volume for business owners.

Each parameter of the operating cycle is a cash flow with magnitude and direction; therefore, from the standpoint of mathematical theory they are vectors.

The conversion of a closed operating cycle is formed by five vectors V_{sv}, D_0, G_0W_0, U_{mf} and Q [2]. The first contour of the operating cycle that is 'capitalization' consists of three vectors V_{sv}, G_0W_0 and D_0, while the second contour that is 'manufacturing' includes the vectors Q, G_0W_0 and U_{mf}.

The graphical interpretation of converting a closed operating cycle formed of three vectors is a triangle. Therefore, the graphical interpretation of a basic (ideal) conversion of a closed operating cycle has the form [5]:
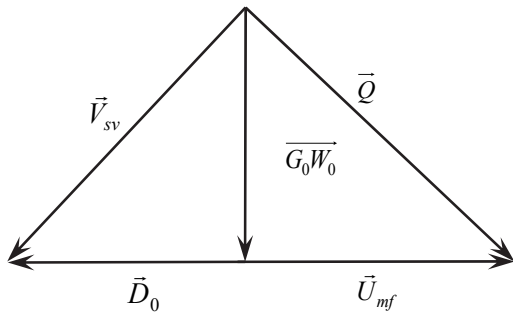
Fig. 2. Basic (ideal) conversion of the operating cycle
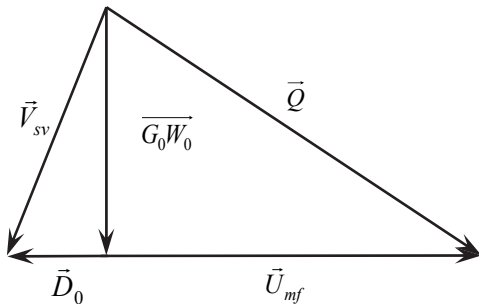of manufacturing capital in engineering business

Here $\vartheta = \dfrac{V_{sv}}{Q} = 1$ is the conversion criterion;

$\lambda = \dfrac{V_{sv}}{G_0 W_0} = 2$ is the capitalization criterion;

$\rho = \dfrac{Q}{G_0 W_0} = 2$ is the resource criterion of

manufacturing capital; $M = \dfrac{D_0}{U_{mf}} = 1$ is the

investment criterion; $k_0 = \dfrac{G_0 W_0}{U_{mf}} = 1$ is the

characteristic of the manufacturing and technological system.

Our studies have shown (Tab. 1) that the conversion level of the manufacturing capital in an operating cycle of a real technological system is $\vartheta < 1$ (for metallurgical enterprises $\vartheta = 0.46$).

Consequently, the graphical interpretation of converting the manufacturing capital in a closed operating cycle has the form [5]:

Fig. 3. Closed operating cycle of converting
the manufacturing capital
in a real engineering business

Here $\vartheta = \dfrac{V_{sv}}{Q} < 1$ is the conversion criterion;

$\lambda = \dfrac{V_{sv}}{G_0 W_0} > 1$ is the capitalization criterion;

$\rho = \dfrac{Q}{G_0 W_0} > 1$ is the resource criterion of the

manufacturing capital; $M = \dfrac{D_0}{U_{mf}} < 1$ is the

investment criterion; $k_0 = \dfrac{G_0 W_0}{U_{mf}} < 1$ is the

characteristic of the manufacturing and technological system.

The business whose conversion criterion of a closed operating cycle is more than unity is an excise one. Fig. 4 presents the graphical interpretation of this cycle [5].
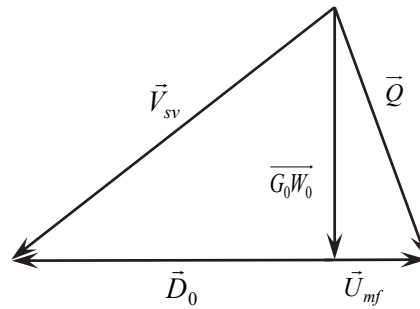

Fig. 4. Closed operating cycle in an excise business

Here $\vartheta = \dfrac{V_{sv}}{Q} > 1$ is the conversion criterion;

$\lambda = \dfrac{V_{sv}}{G_0 W_0} > 1$ is the capitalization criterion;

$\rho = \dfrac{Q}{G_0 W_0} > 1$ is the resource criterion of the

manufacturing capital; $M = \dfrac{D_0}{U_{mf}} > 1$ is the

investment criterion; $k_0 = \dfrac{G_0 W_0}{U_{mf}} > 1$ is the

characteristic of the manufacturing and technological system.

The flowchart for the system of management accounting with transferred operation costs and values (consumer properties) in zones of financial responsibility [15] is presented in Fig. 5.
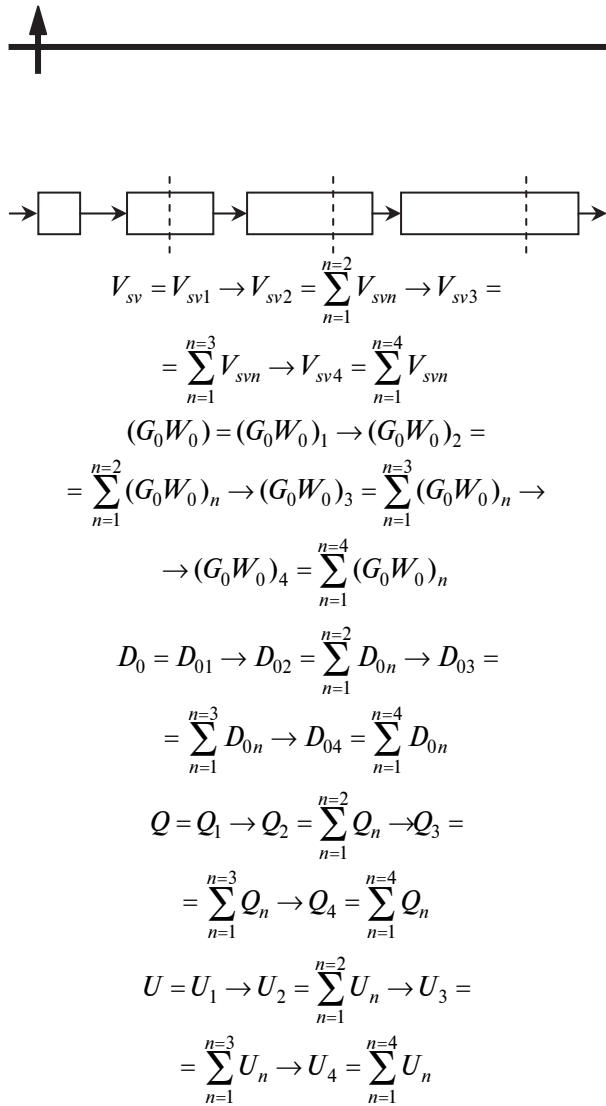
$$V_{sv} = V_{sv1} \rightarrow V_{sv2} = \sum_{n=1}^{n=2} V_{svn} \rightarrow V_{sv3} =$$

$$= \sum_{n=1}^{n=3} V_{svn} \rightarrow V_{sv4} = \sum_{n=1}^{n=4} V_{svn}$$

$$(G_0 W_0) = (G_0 W_0)_1 \rightarrow (G_0 W_0)_2 =$$

$$= \sum_{n=1}^{n=2} (G_0 W_0)_n \rightarrow (G_0 W_0)_3 = \sum_{n=1}^{n=3} (G_0 W_0)_n \rightarrow$$

$$\rightarrow (G_0 W_0)_4 = \sum_{n=1}^{n=4} (G_0 W_0)_n$$

$$D_0 = D_{01} \rightarrow D_{02} = \sum_{n=1}^{n=2} D_{0n} \rightarrow D_{03} =$$

$$= \sum_{n=1}^{n=3} D_{0n} \rightarrow D_{04} = \sum_{n=1}^{n=4} D_{0n}$$

$$Q = Q_1 \rightarrow Q_2 = \sum_{n=1}^{n=2} Q_n \rightarrow Q_3 =$$

$$= \sum_{n=1}^{n=3} Q_n \rightarrow Q_4 = \sum_{n=1}^{n=4} Q_n$$

$$U = U_1 \rightarrow U_2 = \sum_{n=1}^{n=2} U_n \rightarrow U_3 =$$

$$= \sum_{n=1}^{n=3} U_n \rightarrow U_4 = \sum_{n=1}^{n=4} U_n$$

Fig. 5. Flowchart of the transfer of operating cycle parameters required for manufacturing products with competitive advantages on the market

Fig. 6 presents the graphical interpretation of the manufacturing capital conversion of an engineering business based on transferring technological costs and consumer properties (value) of products within 4 zones of financial responsibility being technological stages.
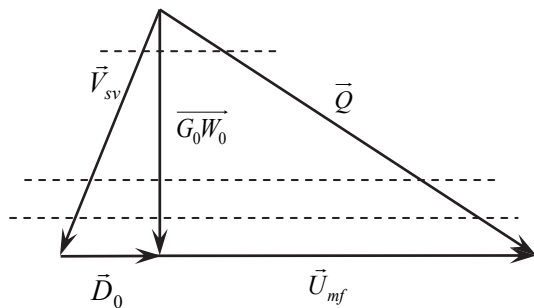
Fig. 6. Conversion of the operating cycle of the manufacturing capital within 4 zones of financial responsibility being technological stages

The borders of technological stages (zones of financial responsibility) are shown as dashed lines.

Study results. The creative model for graphical design of converting the manufacturing capital in an engineering business integrates the production process in the engineering business (internal factor of the conversion process) with the performance of the business in the market (external influence on the engineering business). Product innovations improve the external contour of the operating cycle and technological innovations enhance the internal processes. Both kinds of innovations form intangible assets in the main funds of manufacturing capital in a manufacturing-technological system.

The creative model is presented in the form:

1) parametrical (5) and criterial (7) equations of a closed (continuous) operating cycle of converting the manufacturing capital in the engineering business into the sales volume of products and net income;

2) algorithm for calculating (Tab. 1) the parameters and criteria of conversion on the basis of information received from the stock market about enterprises and their equivalents;

3) algorithm of the graphical design for converting an operating cycle in triangle coordinates (Fig. 2−6).

The graphical design is used to assess the internal cost of tangible and intangible assets in management accounting and in designing innovating projects.

Conclusions and further research. The method of graphical interpretation of the conversion operating cycle of the manufacturing capital into monetary capital in the form and amount equal to sold products is a significant addition to the mathematical model for designing and implementing management accounting.

The results obtained in this study can be used as a basis for:

− developing an algorithm for analyzing and designing scenarios of routing technologies to manufacture products where each technological stage of this product should have a market value, for example, at metallurgical enterprises;

− developing scenarios of designing a production system manufacturing several products in one market sector for a joint stock company, for example, JSC GASPROM.

The graphical interpretation of converting capitals in an operating cycle will be used in the theory and practices of engineering business similar to the graphical interpretation of converting energy in a thermodynamic cycle. The difference between these conversion processes is that the cycle of thermodynamic conversion of energy is formed by two isotherms and two adiabats in the Cartesian coordinate system, while the conversion of an operating cycle of capitals is formed by five vectors of monetary flows in a right-angled coordinate system. In the first case the conversion is characterized by the coefficient of useful activity and in the second case by the conversion level.

Our future research will be dedicated to developing a conversion method based on the transfer principle which might be used as a tool for designing and managing innovative projects in the engineering business.

REFERENCES

1. **Shichkov A.N., Kremlyova N.A., Polovinkina V.D.** Concept of Formation of Infrastructure of Municipal Market of Engineering Knowledge. *St. Petersburg State Polytechnical University Journal. Economics*, 2015, no. 2(216), pp. 52−59. DOI: 10.5862/JE.216.6

2. **Shichkov A.N., Kremlyova N.A., Borisov A.A.** Designing the operation cycle of a manufacturing-technological system. *St. Petersburg State Polytechnical University Journal. Economics*, 2016, no. 2(240), pp. 89−97. DOI: 10.5862/JE.240.9

3. **Shichkov A.N.** Teoriia i praktika inzhenernogo biznesa i menedzhmenta. Vologda: VoGU, 2016. 131 s. (rus)

4. **Shichkov A.N.** Designing Manufacturing-Technological Systems. *Scientific Israel-Technological Advantages*, 2016, vol. 18, no. 1, pp. 89−106.

5. **Shichkov A.N.** Innovative Enhancement of an Engineering Business: Operation Cycle Method. Scientific Israel-Technological Advantages, 2016.

6. Restrukturizatsiia ekonomiki: teoriia i instrumentarii: monogr. Pod red. A.V. Babkina. SPb.: Izd-vo Politekhn. un-ta, 2015. S. 664. (rus)

7. AO «Vologodskii zavod stroitel'nykh konstruktsii i dorozhnykh mashin»: ofits. sait. URL: http://dormash.com (data obrashcheniia: 18.08.2016). (rus)

8. **Solov'eva D.N.** Parametry otsenki potrebitel'skikh svoistv produktsii v denezhnom vyrazhenii : mater. region. nauch. konf. VIII Ezhegodnoi nauch. sessii aspirantov i molodykh uchenykh. 2015. T. 1: Tekhnicheskie nauki. Ekonomicheskie nauki. S. 353−356. (rus)

9. **Tukkel' I.L., Golubev S.A., Surina A.V., Tsvetkova N.A.** Metody i instrumenty upravleniia innovatsionnym razvitiem promyshlennykh predpriiatii. Pod red. I.L. Tukkelia. SPb.: BKhV-Peterburg, 2013. 208 s. (rus)

10. **Shichkov A.N.** The Content of the High Engineering Education. *World Applied Science*, 2013, vol. 27 (Education, Law, Economics, Language and Communication), pp. 343−348.

11. **Shichkov A.N.** Fiziko-matematicheskaia model' operatsionnogo menedzhmenta v proizvodstvenno-tekhnologicheskikh sistemakh inzhenernogo biznesa. *Vestnik Vologodskogo gosudarstvennogo universiteta*. 2015. Vyp. 5/15. S. 36−41. (rus)

12. Severstal' − Godovye otchety. URL: https://www.severstal.com/rus/ir/results_reports/annual_reports/index.phtml (data obrashcheniia: 18.08.2016). (rus)

13. NMLK − Godovye otchety. URL: http://nlmk.ru/investor-relations/reporting-center/annual-reports/ (data obrashcheniia: 18.08.2016). (rus)

14. Magnitogorskii metallurgicheskii kombinat − Godovye otchety. URL: http://mmk.ru/for_investor/annual_reports/ (data obrashcheniia: 18.08.2016). (rus)

15. **Shichkov A.N.** Designing of Innovative Tasks for Manufacturing-Technological Systems. Fundamental and Applied Studies in the Pacific and Atlantic Oceans Countries: papers and commentaries of The 1st International Academic Congress. Japan, Tokyo, 25 October 2014. Tokyo University Press, pp. 159−165. (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Шичков А.Н., Кремлёва Н.А., Половинкина В.Д.** Концепция формирования муниципального рынка инженерных знаний // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2015. № 2(216). С. 52−59. DOI: 10.5862/JE.216.6

2. **Шичков А.Н., Кремлёва Н.А., Борисов А.А.** Проектирование операционного цикла производ-ственно-технологической системы // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2016. № 2(240). С. 89−97. DOI: 10.5862/JE.240.9

3. **Шичков А.Н.** Теория и практика инженерного бизнеса и менеджмента. Вологда: ВоГУ, 2016. 131 с.

4. **Shichkov A.N.** Designing Manufacturing-

Technological Systems // Scientific Israel-Technological Advantages, 2016, vol. 18, no. 1, pp. 89−106.

5. **Shichkov A.N.** Innovative Enhancement of an Engineering Business: Operation Cycle Method. Scientific Israel-Technological Advantages, 2016.

6. Реструктуризация экономики: теория и инструментарий: моногр. / под ред. А.В. Бабкина. СПб.: Изд-во Политехн. ун-та, 2015. С. 664.

7. АО «Вологодский завод строительных конструкций и дорожных машин»: офиц. сайт. URL: http://dormash.com (дата обращения: 18.08.2016).

8. **Соловьева Д.Н.** Параметры оценки потребительских свойств продукции в денежном выражении : матер. регион. науч. конф. VIII Ежегодной науч. сессии аспирантов и молодых ученых. 2015. Т. 1: Технические науки. Экономические науки. С. 353−356.

9. **Туккель И.Л., Голубев С.А., Сурина А.В., Цветкова Н.А.** Методы и инструменты управления инновационным развитием промышленных предприятий / под ред. И.Л. Туккеля. СПб.: БХВ-Петербург, 2013. 208 с.

10. **Shichkov A.N.** The Content of the High Engineering Education // World Applied Science, 2013, vol. 27 (Education, Law, Economics, Language and Communication), pp. 343−348.

11. **Шичков А.Н.** Физико-математическая модель операционного менеджмента в производственно-технологических системах инженерного бизнеса // Вестник Вологодского государственного университета. 2015. Вып. 5/15. С. 36−41.

12. Северсталь − Годовые отчеты. URL: https://www.severstal.com/rus/ir/results_reports/annual_reports/index.phtml (дата обращения: 18.08.2016).

13. НМЛК − Годовые отчеты. URL: http://nlmk.ru/investor-relations/reporting-center/annual-reports/ (дата обращения: 18.08.2016).

14. Магнитогорский металлургический комбинат − Годовые отчеты. URL: http://mmk.ru/ for_investor/ annual_reports/ (дата обращения: 18.08.2016).

15. **Shichkov A.N.** Designing of Innovative Tasks for Manufacturing-Technological Systems. Fundamental and Applied Studies in the Pacific and Atlantic Oceans Countries: papers and commentaries of The 1st International Academic Congress. Japan, Tokyo, 25 October 2014. Tokyo University Press, pp. 159−165.

KREMLYOVA Natal'ia A. − Vologda State University.
160000. Lenina str. 15. Vologda. Russia. E-mail: kremleva-n@yandex.ru

КРЕМЛЁВА Наталия Анатольевна − доцент Вологодского государственного университета, кандидат экономических наук.
160000, ул. Ленина, д. 15, г. Вологда, Россия. E-mail: kremleva-n@yandex.ru

BORISOV Aleksandr A. − Vologda State University.
160000. Lenina str. 15. Vologda. Russia. E-mail: uiiop@mh.vstu.edu.ru

БОРИСОВ Александр Алексеевич − доцент Вологодского государственного университета, кандидат экономических наук.
160000, ул. Ленина, д. 15, г. Вологда, Россия. E-mail: uiiop@mh.vstu.edu.ru

FROLOV Aleksandr A. − Vologda State University.
160000. Lenina str. 15. Vologda. Russia. E-mail: fa@mh.vstu.edu.ru

ФРОЛОВ Александр Анатольевич − доцент, декан Вологодского государственного университета, кандидат технических наук.
160000, ул. Ленина, д. 15, г. Вологда, Россия. E-mail: fa@mh.vstu.edu.ru

УСЛОВИЯ ПУБЛИКАЦИИ СТАТЕЙ

в журнале «Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки»

ОБЩИЕ ПОЛОЖЕНИЯ

Журнал «Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки» является периодическим печатным научным рецензируемым изданием. Зарегистрировано Федеральной службой по надзору в сфере информационных технологий и массовых коммуникаций (Роскомнадзор). Свидетельство о регистрации ПИ № ФС77-52146 от 11.12.2012 г. С 2008 года выпускался в составе сериального периодического издания «Научно-технические ведомости СПбГПУ» (ISSN 1994-2354).

Издание с 2002 года входит в Перечень ведущих научных рецензируемых журналов и изданий (перечень ВАК) и принимает для печати материалы научных исследований, а также статьи для опубликования основных результатов диссертаций на соискание ученой степени доктора наук и кандидата наук по следующим основным научным направлениям: Менеджмент, Макроэкономика, Мировая экономика, Региональная экономика, Экономика и менеджмент предприятия, Маркетинг, Финансы, Бухгалтерский учет, Налогообложение, Управление инновациями и др. Научные направления журнала учитываются ВАК Минобрнауки РФ при защите докторских и кандидатских диссертаций в соответствии с Номенклатурой специальностей научных работников.

Сведения о публикации представлены в РИНЦ Реферативном журнале ВИНИТИ РАН, в международной справочной системе «Ulrich`s Periodical Directory».

Периодичность выхода журнала — шесть номеров в год.

ПРАВИЛА ДЛЯ АВТОРОВ

Требования к оформлению статей

1. Рекомендуемый объем статей 12—20 с. формата А4 с учетом графических вложений. Количество графических вложений (диаграмм, графиков, рисунков, фотографий и т. п.) — не более шести.

2. Авторы должны придерживаться следующей обобщенной структуры статьи: вводная часть 0,5—1 с. (актуальность, существующие проблемы); основная часть (постановка и описание задачи, изложение и суть основных результатов); заключительная часть 0,5—1 с. (выводы, предложения); список литературы, оформленный по ГОСТ 7.05—2008.

3. Число авторов статьи не должно превышать трех.

4. Набор текста осуществляется в редакторе MS Word, формулы — в редакторе MS Equation или MythType. Таблицы набираются в том же формате, что и основной текст.

Шрифт: гарнитура Times New Roman, размер шрифта — 14 п. Таблицы большого размера могут быть набраны 12 кеглем. Поля: слева — 3 см, сверху и снизу — 2,5 см, справа — 2 см. Текст без переносов. Межстрочный интервал — 1,5. Текст выравнивается по ширине полосы. Абзацный отступ 1 см.

5. Рисунки, таблицы, фотографии размещаются по тексту статьи.

Требования к представляемым материалам

Для опубликования статьи в журнале «Научно-технические ведомости Санкт-Петербургского государственного университета. Экономические науки» вместе с материалами статьи должны быть представлены:

• аннотация на русском и английском языках;

• ключевые слова (пять-семь) на русском и английском языках;

• для статей аспирантов или соискателей ученой степени кандидата наук — заверенная в отделе кадров рекомендация научного руководителя, отражающая актуальность, значимость, ценность и новизну полученных результатов. В качестве выводов необходимо указать, что статья может быть рекомендована для опубликования в журнале «Научно-технические ведомости СПбГПУ. Экономические науки», Научный руководитель несет ответственность за содержание статьи, достоверность представленных материалов.

С авторами статей заключается издательский лицензионный договор.

Представление всех материалов осуществляется через Электронную редакцию.

Рассмотрение материалов

Представленные материалы (см. требования) первоначально рассматриваются редакционной коллегией и передаются для рецензирования. После одобрения материалов, согласования различных вопросов с автором (при необходимости) редакционная коллегия сообщает автору решение об опубликовании статьи или направляет автору мотивированный отказ.

При отклонении материалов из-за нарушения сроков подачи, требований по оформлению или как не отвечающих тематике журнала материалы не публикуются и не возвращаются.

Редакционная коллегия не вступает в дискуссию с авторами отклоненных материалов.

Публикация научных статей в журнале осуществляется на безвозмездной основе, независимо от места работы автора.

При поступлении в редакцию значительного количества статей их прием в очередной номер может закончиться ДОСРОЧНО.

Более подробная информация размещена на сайте: ntv.spbstu.ru

Для получения справочной информации обращайтесь в редакцию:

8(812)297—18—21 с 10^{00} до 18^{00} Анна Андреевна,
или по e-mail: economy@spbstu.ru