International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:12, No:2, 2018

Commercialization of Technologies, Productivity and Problems of Technological Audit in the Russian Economy

E. A. Tkachenko, E. M. Rogova, A. S. Osipenko

***Abstract*—**The problems of technological development for the Russian Federation take on special significance in the context of modernization of the production base. The complexity of the position of the Russian economy is that it cannot be attributed fully to developing ones. Russia is a strong industrial power that has gone through the processes of destructive de-industrialization in the conditions of changing its economic and political structure. The need to find ways for re-industrialization is not a unique task for the economies of industrially developed countries. Under the influence of production outsourcing for 20 years, the industrial potential of leading economies of the world was regressed against the backdrop of the ascent of China, a new industrial giant. Therefore, methods, tools, and techniques utilized for industrial renaissance in EU may be used to achieve a technological leap in the Russian Federation, especially since the temporary gap of 5-7 years makes it possible to analyze best practices and use those technological transfer tools that have shown the greatest efficiency. In this article, methods of technological transfer are analyzed, the role of technological audit is justified, and factors are analyzed that influence the successful process of commercialization of technologies.

***Keywords*—**Technological transfer, productivity, technological audit, commercialization of technologies

I. Introduction

UP-TO-DATE Russian industry requires urgent modernization. According to official data, the average age of the most important part of basic production assets in industry - machinery and equipment - is 13.3 years, while the share of new ones (up to 5 years) accounts for only 14%, and, at the same time, the proportion of fully worn-out machinery and equipment in manufacturing industries is 18.1% [21]. This situation requires intensification of efforts to technologically update industry through the transfer of advanced technologies. Many researchers note that labor productivity is a direct function of the results of innovation. Such a position is, for example, expressed in the works of Khan [1], Bassanini et al. [2] Bassanini and Ernst [3] and Scarpetta and Tressel [4].

Bernard and Jones [5] define productivity as a result of either domestic innovation or technology transfer from the frontier economy. Labor productivity reflects the volume of output created by one employee per unit of time. This indicator may be calculated in natural and cost-based units.

Comparisons of labor productivity are carried out by a number of international organizations and economic departments of state structures, such as the Organization for Economic Cooperation and Development (OECD), American Bureau of Labor Statistics (BLS USA), Japanese Performance Center (JPC), etc. Lack of comparable data both in international and, for a number of cases, also in domestic statistics, significantly limits the possibilities of analysis.

Fig. 1 shows data on labor productivity in foreign countries, in the Russian Federation, Moscow and St. Petersburg, calculated as the ratio of GDP (GRP) to the number of people employed in the economy, in US dollars at purchasing power parity for 2011.

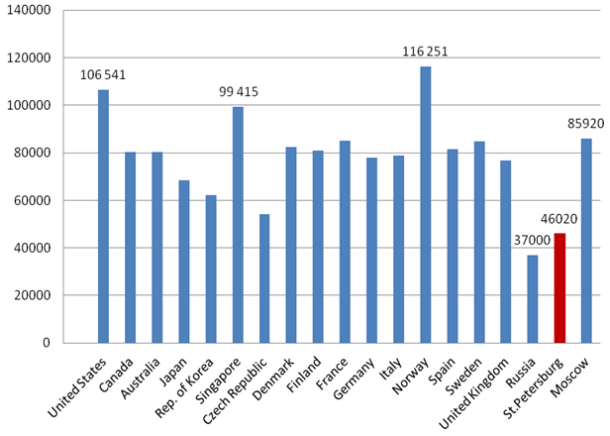

Fig. 1 Labor productivity in foreign countries, Russia, Moscow and St. Petersburg in 2011 (in US dollars, in 2011 prices, at purchasing power parity for 2011) Source: BLS [6], Federal State Statistics Service [7], author's calculations

As follows from the data presented, labor productivity in the St. Petersburg economy in PPP in 2011 amounted to US $46,000 per employee, which is somewhat higher than labor productivity in Russia at large ($37,000), but it is significantly lower than labor productivity in industrialized countries, and lower than in the Moscow economy ($85,900). The choice of this set of countries for comparison is determined by the specifics of economy of St. Petersburg, its structure and development rates. St. Petersburg is a megacity with a population comparable to the population of some countries and a level of economic development that approximates it to a group of industrialized countries. The problem of personnel deficit is acute for St. Petersburg, and increase in labor productivity in these conditions is the most significant reserve of economic growth, the provision of which is not possible due to low efficiency of technological transfer (TT).

II. Methodology and Background

Authorial research has shown that, in accordance with traditional approach, transfer of technologies is generally viewed from the standpoint of innovative management. A similar opinion is presented, for example, in [8]-[10]. This is due to emphasis on the early stages of developing new technologies, conducting relevant research, development and technological works. The work of Burgelman et al. [11] reflects a similar position. Obviously, such an opinion has been developed historically based on the origin of the concept of "technology transfer". Initially, technological transfer was understood as the process of transferring technologies from military sector to civilian industries, or, as it was understood by the National Institute of Standards and Technology (USA), technology transfer is a transfer of knowledge and technology developed in federal laboratories and research centers to the private sector and their commercialization (Williamson [12]).

Methods of studying TT suggest classification of TT types based on method of creating and transferring technologies. For the Russian Federation, such forms of TT as business incubators are relevant, the development of which has been widely discussed in scientific literature (Rogova [13])

In recent years, the efforts in the field of TT promoting in the Russian Federation have been aimed at developing various forms of spillover from universities and formation of academic entrepreneurship. This TT form has been analyzed in detail by [14]-[18] and Sandstrom, Wennberg, Wallin and Zherlygin made the clear critical literature review in this sphere in 2016 [19].

The study showed that, in accordance with the traditional approach, the transfer of technologies is generally considered above all from the standpoint of innovative management. This is due to the emphasis on early stages of developing new technologies, conducting relevant research, experimental design and technological work. The analysis conducted by the authors showed that this approach reflects the interests of only one group of subjects of technological transfer, developers of new technologies. However, from the standpoint of technology recipients, which are industrial enterprises, technological transfer in modern conditions does not display the signs of innovation process. It is carried out within the framework of the solution of typical management, design and engineering tasks. It is established that the results of technology transfer are well predictable, risks and uncertainties are minimal for both a transferring party and a recipient. In the developed market of technologies, the transfer process is of a routine nature, comparable in its consequences with the acquisition of fixed production assets.

In the field of technological transfer, due to the influence of its inherent institutional features, economic and psychological features of management, technological specifics which are inherent in industrial enterprises, etc., as the research showed, the preferred method of self-organization is an inter-company network formed as a technology transfer network.

III. Network Technology Transfer Model

The authors analyzed the experience of operation of such Russian and foreign (including transnational) networks (IRC, EEN, RTTN, etc., information about them is presented in Table I), which allowed to substantiate the conclusion that technology transfer networks can be considered as a tool for forming innovative production clusters.

TABLE I
Performance Indicators of Some Technology Transfer Networks (Osipenko [20])

Network	Coverage	Structure	Trends
EEN	50 countries, including 27 EU countries	About 250 consortiums; 600 organizations - "contact points"	Integrated services in the field of supporting business development and innovation, including services to support business cooperation, transfer of knowledge and technologies
IRC	33 countries, including EU countries, as well as Chile, Iceland, Israel, Norway, Switzerland, Turkey	71 consortiums, 243 partner organizations, 14 network thematic groups	Technical support of innovation organizations, organization of technological cooperation, technological audit, information and technology exchange
RTTN	Russia and CIS countries; partnership projects with European countries	4 Russian regional networks, 74 certified members, including foreign members (CIS)	Transfer of technologies between scientific sector and companies, as well as within the industrial sector; search for partners for cooperation in the development and implementation of new knowledge-intensive technologies
RFR	French and Russian technological network	25 Russian organizations, 4 French consortiums	Creation of technological partnerships among enterprises and organizations of Russia and France
BRIN	British and Russian Innovation Network	16 Russian and 13 British technology transfer centers	Assistance to British and Russian research and production organizations in the coordination and implementation of industrial technology transfer

Operation of TT networks as a tool for the formation of innovative production clusters is aimed at solving a wide range of tasks, which requires unification of procedures for intra-network interaction and interaction of network participants with customers. In the process of research, the following staging of this process was identified (Fig. 2): (1) Identification of customer's TT potential; (2) Identification of technological profiles; (3) Search for technology partners and organization of cooperation; and (4) Conclusion of agreement on TT. At the same time, the profiles of technological requests and proposals are recommended to be prepared during the technological audit, the purpose of which is to assess the organization's ability to implement new technologies, work with technology partners, and solve innovative problems.

IV. Problems of Technological Audit

The first and most important stage of a company's incorporation into TT network is a technological audit, which

will include a number of stages:

At the same time, the following activities are carried out at the first stage:

- Comprehensive assessment of feasibility and capabilities of the enterprise to create a product containing IPI (Intellectual Property Item), for which, the external environment should be analyzed at the level of the macromedia and direct environment;
- Assessment of market needs for new products and availability of competitors (analysis of the external environment), for which systematic marketing and patent studies are conducted using up-to-date information technologies;
- Assessment of legal factors (degree and effectiveness of IPI legal protection) in specific conditions;
- Assessment of economic, technological and other factors;
- Analysis of the internal environment, i.e. determination of an organization's capability to create a new product, for which the personnel potential, organization of management, production, financial, marketing sections, etc. are assessed.

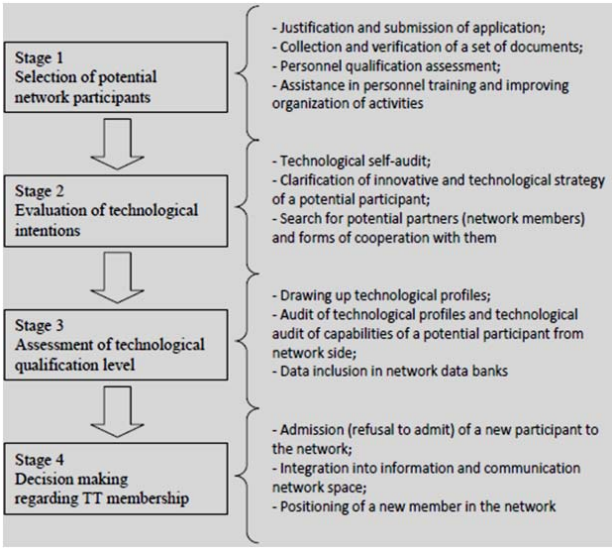

Fig. 2 Principles of forming the architecture of TT networks

At the second stage, the following is required:

- To assess the resources (personnel, material, financial, etc.);
- To assess the role and responsibilities of personnel (hiring, training, advanced training, nature of interaction between managers and designers, as well as among employees) in the process of creating and implementing IPI.

At the third stage, the potential of implementation of the IPIs identified by OIS into economic turnover should be assessed as follows:

- Assessment of competitiveness of the product containing IPI;
- Assessment of the value of rights for IPI;
- Accounting registration of IPI as an intangible asset (ITA);
- Selection of ways to use IPI.

At the fourth stage (ensuring of IPI protection) the following is carried out:

- Monitoring as to the use of IPI in production activities of the enterprise;
- Monitoring as to the implementation of the company's rights as IPI owner (RIA) in company's and the related markets;
- Monitoring as to the legislation of the Russian Federation and jurisdictions of company's markets in the field of IP and TT in order to ensure timely correction of mechanisms for protecting company's rights with respect to its IPIs.

Let us consider in detail the nature of the measures taken in the process of formation of portfolio of rights on IPI. They presuppose the following: systematic identification of protected RIAs; choice of legal protection forms; securing IPI rights for the company; acquisition of rights to use IPIs owned by other companies.

In order to perform this work at the enterprise, it is required to create a standing expert commission, the object of activity of which is the following: identification of the protected RIAs; preparation of proposals for assigning the rights for RIAs identified; choice of commercially significant RIAs and methods of their legal protection, etc. In determining the conditions for IP commercialization (price, allocation of rights for IP created), the volume of rights is taken into account belonging to the performer regarding previous IP, which is to be used in the course of performance of a commercial contract.

In this regard, it is advisable to carry out the inventory of previously created RIAs at the enterprise, upon the results of which it is required to identify the protected RIAs, determine the possibility of assigning the rights for them to the enterprise and choose the legal protection method. Systematic identification of protected RIAs provides for the following activity:

- Inventory of the previously created RIAs;
- Inventory of the RIAs created as a result of R&D conducted upon their completion;
- Identification of the protected RIAs in the course of employees' performance of their duties (the procedure for notification of the establishment of such RIAs is determined by a local regulatory document).

All technical and normative documentation, computer programs, databases created at the enterprise, should constitute the enterprise's IP, the rights for which, according to Part 4 of the Civil Code of the Russian Federation, may be fixed as an invention; utility model; production prototype; computer programs; database; IPI topology; trade secret. The choice of the form and legal protection method depends on the attribution of RIA: to patent law objects (invention, utility model, production prototype); to copyright objects (databases, computer programs); to IPI topologies; and, to trade secrets (know-how).

When choosing the legal protection method, it is required to take into account the following: object of protection; peculiarities of the procedure for registration of rights; duration of protection; degree of RIA protection achieved by the chosen method; ways to use RIA; activity recognized as a violation of rights for this IPI type; and, availability of alternative forms of IPI protection. The choice between the patent's protection form and protection in the form of confidential information depends to a large extent on the features and conditions of using scientific and technical result, financial capabilities of the enterprise, and its technical policy, as well as the situation in the market of similar products.

The peculiarities of patent protection are the availability of title documents. However, patent protection is associated with the disclosure of information about a patented solution to an unlimited number of persons. The peculiarities of copyright protection are determined by the fact that only the form of information presented is to be protected, and not the content. The most effective is complex protection of the object with simultaneous use of information protection in a restricted access mode, patent protection (as an invention, utility model, etc.).

The recommended list of organizational measures aimed at providing limited access to RIAs is as follows:

- Establishment, by the order of head of the organization, of the list of objects to be protected and restricted access mode;
- Reflection in the agreements with those employees who have access to the sites protected in a restricted access mode, of obligations to comply with confidentiality mode and responsibility for its violation;
- In the case of access to confidential information of employees of third-party organizations, the agreements should provide for obligations to comply with confidentiality mode and responsibility for its violation.

Mandatory conditions for IPIs implementation into civil circulation are as follows: documentary establishment of the fact of IPI creation; establishment of the owner of rights for IPI; assessment of its cost; accounting registration of IPI as an intangible asset. Basic recommended types of use and commercialization of IP: application in own production; transfer of the right for use; assignment of rights; contribution to equity capital. It should be noted that the transfer of IPI rights under license is the main legal way of TT in international trade.

The selection of certain forms and means of IP commercialization should be determined as follows: based on the results of marketing research, on the basis of which the expected profit is generated according to specific trend of IPI use; on the basis of the principle of achieving the greatest economic effect (profit) - whether the right holder receives more profit from IPI use at his own production facilities for the production of competitive products or from the transfer of IPI rights to third parties. In the event the situation does not allow the enterprise to remain a monopoly owner of a technical solution (due to state policy, lack of the company's own resources to meet market requirements, or due to other reasons), another form of cooperation is recommended with the applicant for IPI possession (production cooperation, joint venture, transfer of IPI rights on a licensed basis).

Technological audit may be carried out in different ways. First, it is the use of own personnel with appropriate knowledge and understanding of problems. Second, it is the involvement of external independent experts (industry experts, employees of consulting and audit companies and their specialized TA-oriented units, representatives of TT networks and centers, etc.). Third, it is the involvement of representatives of potential partners on cooperation and consumers of new technologies. In the thesis, a conclusion is justified that the fourth principle is the most preferable one - mixed principle of formation of the TA group.

In addition to considering the potential of TT in the course of TA, it is also required to assess the potential of commercializability of technologies. This is achieved by including questions into questionnaires and interviews related to the assessment of the price for developing a new technology, acceptability of such costs (availability of alternatives), potential for commercial replication of the technology, assessment of the level of preparedness of a new technology for transfer, including the need for its revisions and adaptation for industrial use, and also the assessment of time expenditures for the transfer and commercialization, and their acceptability for the organization.

The authors have put forward a hypothesis that the commercialization potential is influenced by the following factors: K1 -acceptability of development cost; K2 - possibility of scaling; K3 - essentiality of competitive advantages; K4 - availability of market; K5 - degree of preparedness of technologies for transfer (industrial development is carried out or being carried out, availability of prototypes, it is at the stage of design and development work, etc.). In order to check the hypothesis, we have conducted semi-structured interviews with companies dealing with technology transfers. An initial sample comprised 238 companies from the industrial sector of the Russian economy. The geography of the survey covered the European regions of the Russian Federation, for objective reasons related to the level of industrialization of districts; most of the companies are located in the North-Western Federal District (St. Petersburg and the Leningrad Region), in the Central Federal District (Moscow, the Moscow Region), in the Volga Federal District (Republic of Tatarstan, the Nizhny Novgorod Region) and in the Urals Federal District (the Sverdlovsk Region, the Chelyabinsk Region). According to the results of the survey, 82 companies were chosen which had carried out the process of IPI commercialization over the past three years. In order to formalize the information, a point-based model was proposed for assessing factors affecting the success of the TT process (see Table II).

The general question was to assess the state of the factor at the time of making a decision regarding TT on a scale from 0 to 3 points. Similarly, it was suggested to assess TT success on a scale of 0 to 3 points. The results of the simulation are presented in Table III.

TABLE II
SCALE FOR ASSESSING FACTORS AFFECTING THE SUCCESS OF THE TT PROCESS

Factor No.	Response 1	Response 2	Response 3	Response 4
K1	3	2	1	0
K2	3	2	1	0
K3	3	2	1	0
K4	3	2	1	0
K5	3	2	1	0

Thus, it is obvious that the hypothesis has been confirmed only in part: with a high value of the coefficient of determination (98%) and model importance indicators only one factor may be recognized as affecting the TT process - availability of demand (market) for the TT object.

Based on the results of TA conducted at the enterprise, new technologies may be identified that make up intellectual property items (IPI). To get them involved into economic circulation and to obtain a positive economic effect, special measures are required to manage the intellectual property of the enterprise. Marketing of scientific and technical products should not be limited to the domestic market. International marketing in this area is focused on TT in the following forms: licensing and joint production on the basis of the license provided; rendering of special services (engineering, consulting, etc.); and, submitting applications for participation in international (state, interstate and private) scientific and technical programs.

TABLE III
REGRESSION STATISTICS AND DISPERSION ANALYSIS OF THE SIMULATION

Regression statistics						
Multiple R	0.990028577					
R-square	0.980156584					
Normalized R-square	0.978833689					
Standard Error	0.109816077					
Observations	82					
Dispersion analysis						
	df	*SS*	*MS*	*F*	*Relevance F*	
Regression	5	44.67578	8.935156	740.9182	2.55065E-62	
Balance	75	0.904468	0.01206			
Total	80	45.58025				
	Coefficients	*Standard error*	*t-Statistics*	*P-Value*	*Lower 95%*	*Upper 95%*
Y-crossing	-0.07504272	0.041185	-1,82209	0.072428	-0.157087297	0.007002
Variable X 1	0.009019351	0.012458	0.723954	0.471346	-0.015799159	0.033838
Variable X 2	0.025915237	0.020823	1,24454	0.217176	-0.015566599	0.067397
Variable X 3	0.009456957	0.018929	0.49961	0.618812	-0.028250887	0.047165
Variable X 4	0.99715387	0.016858	59.15192	1.09E-64	0.963571997	1.030736
Variable X 5	-0.00882167	0.01409	-0.62609	0.533157	-0.036890631	0.019247

Promotion of Russian technologies to the markets all over the world is connected with a number of difficulties, which include the following:

1. Lack of qualified specialists capable of providing support for TT. Such specialists are not being trained in any educational institution of the country, and the process of their self-education is very slow and unsystematic.
2. Lack of harmonization with international norms and internal contrariety of the Russian legislation related to legal protection and transfer of intellectual property.
3. Imprecise specificity of the rights for intellectual property items already involved in economic turnover because of the diversity and incompleteness of their protection modes established both during the Soviet period and during the post-reform period, including inventions "for official use".
4. Lack of sufficient funds for Russian developers to implement the strategy of foreign patenting.

Thus, technological audit is not a solution of the TT problem, but a procedure for identifying opportunities.

V. CONCLUSION

Following the results of the research, a conclusion has been made that, for the successful transfer of technologies and their promotion in domestic and global industrial markets, the following is required:

- a developed system of technological marketing, including both an internal marketing subsystem of developers and a specialized TT infrastructure – a system of TT industrial fairs, networks, centers, etc.;
- Formation of a system for training specialists within the framework of higher or secondary vocational education in the field of TT and promotion of innovative products;
- Improvement of the legal basis as to the protection of intellectual property, as well as creation of a network of law firms, which, on the one hand, may provide legal support for the entire TT chain, from intellectual property inventory and implementation of TA, selection of the best and the most effective form of protection, registration of patent applications, and, on the other hand, control over non-violation of patents, filing claims as to offenders, and, if necessary, representation of interests of developers and copyright holders during arbitration proceedings, including international arbitration.

REFERENCES

[1] S. T. Khan Productivity Growth, Technological Convergence, R&D, Trade, and Labor Markets: Evidence from the French, IMF Working Paper 2006 International Monetary Fund.
[2] A. Bassanini, P. Pilat, S. Scarpetta, and P. Schreyer, "Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level," OECD Economics Department Working Papers No. 248 2000 (Paris: Organization for Economic Cooperation and Development, Economics Department).
[3] A., Bassanini, E. Ernst, 2002, "Labour market institutions, product market regulations and innovation: cross country evidence," OECD Economics Department Working Papers No. 316 (Paris: Organization for Economic Cooperation and Development, Economics Department).
[4] S. Scarpetta, T. Tressel, "Productivity and Convergence in a Panel of OECD Industries: Do Regulations and Institutions Matter?" OECD 2002, Economics Department Working Papers 342.
[5] A. Bernard, and C. Jones, "Productivity and Convergence Across U.S. States and Industries," in Long-Run Economic Growth, eds. S. Durlauf, J. Helliwell and B. Raj, Physica-Verlag, 1996 Heidelberg.
[6] Bureau of Labor Statistics. Online (https://www.bls.gov/news.release/prod4.nr0.htm).
[7] Federal State Statistics Service. Online (http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/en/figures/labour/).
[8] S. V. Valdaytsev Crisis management on the basis of innovations: Publishing house C. - Peterb. un-that, 2001
[9] P. N., Zavlin, A. Vasilyev.— Efficiency assessment innovations / St. Petersburg: Business-pressa publishing house, 1998.
[10] A. A. Zaytsev The international analysis of an industry labor productivity in 1991-2008 – M.: Institute of economy of RAS, 2014.
[11] R. A. Burgelman, L. R. Sayles, Inside Corporate Innovation: Strategy, Structure and Managerial Skills, The Free. Press, 1986. (Paper 1988)
[12] O. E. Williamson, "The Economic Institutions of Capitalism", New York: Free Press, 1985.
[13] E Rogova. The effectiveness of business incubators as the element of the universities' spin-off strategy in Russia//International Journal of Technology Management and Sustainable Development. 2014. Vol. 13. No. 3. P. 265-281.
[14] A. Bergek, C. Norrman, Incubator best practice: A framework, 2008, Technovation, (28), 1-2, 20-28.
[15] H. Hall, B. Donald Innovation and Creativity on the Periphery: Challenges and Opportunities in Northern Ontario http://martinprosperity.org/media/pdfs/Innovation_and_creativity_on_the_Periphery-H_Hall-B_Donald.pdf.
[16] R. Wieser Research And Development Productivity And Spillovers: Empirical Evidence At The Firm Level Journal of Economic Surveys September 2005 Volume 19, Issue 4 Pages 535–696.
[17] D. B. Audretsch, Innovation and Industry Evolution (MIT Press, Cambridge) 1995.
[18] D. B. Audretsch, P. Stephan,), Company-scientist locational links: the case of biotechnology, American Economic Review 1996 86(4): 641-652.
[19] C. Sandstrom, K. Wennberg, M.W. Wallin, Yu. Zherlygin Public policy for academic entrepreneurship initiatives: a review and critical discussion J Technol Transf DOI 10.1007/s10961-016-9536-x.
[20] A. S. Bodrunova (Osipenko) Technological audit, a transfer and commercialization of technologies in structure of the market of intellectual property//Economic sciences. – 2012. – No. 4. – Page 163-168.
[21] Russia in figures - 2017. Online (http://www.gks.ru/bgd/ regl/b16_11 /Main.htm)

Elena Tkachenko (1969) got her Doctor degree from Saint Petersburg State University of Economics and Finance in 2007. Now she holds the position of the director of Master program at the St. Petersburg State University Of Economics. She is a professor of the Department of the Economy and management of enterprise and industrial complexes, (2009 -now). Author more than 120 scientific and methodical works, including 10 textbooks and 7 monographs. The sphere of scientific interests –innovations, investments, management of the intellectual capital, Industrial development, finance, regional development

Elena Rogova (1969) holds the position of Dean of the Institute of Economic and Finance and the head of Finance department of St.-Petersburg campus of National Research University Higher School of Economics. She got her Doctor degree from St.-Petersburg State University of Economics and Finance in 2006. Her research interests lay in the sphere of financial management of innovation-based companies, venture capital and innovation management.

Alina Osipenko (1987) received her candidate's degree in 2013 at the St. Petersburg State University of Economics. Now she takes a position of the leading researcher of New Industrial Development Institute (St. Petersburg, Russia). She is an author more than 20 scientific and methodical works in the field of a technological transfer and technological audit.