

# Economic Efficiency of Innovative Materials for Sectors of Economy

*Tatyana Miroshnikova*<sup>1,\*</sup>, and *Natalia Taskaeva*<sup>2</sup>

<sup>1</sup> Vladivostok State University of Economics and Service, 690014 Gogol str., 41, Vladivostok, Russia

<sup>2</sup> Moscow State University of Civil Engineering, 129337 Yaroslavskoe sh.26, Moscow, Russia

**Abstract.** The paper proposes an approach to the assessment of the economic efficiency of innovative anti-corrosion coatings for sectors of the national economy of the Russia on the basis of a synthesis of strategic sectoral and cost analysis. According to the authors, a comparative analysis of composite polymeric anticorrosion protecting coatings with similar products, estimating of direct and indirect economic effect and prognosis of implementation, forms a deeper understanding of the role of innovative technologies in the Russian state development of import substitution, the investment attractiveness of Russian industries in the new part technologies, applied research activities of private companies. Metal consumption sectors of the economy were chosen as an object of research, as they are characterized by the use of the following products: industrial construction and reconstruction, nuclear and thermal power, chemical, oil and gas, utilities, food processing, automotive, shipbuilding, aviation and rocket science, other industry. Basic modeling of implementation of anticorrosion protecting coatings in industrial enterprises was carried out on the basis of generating energy enterprises as one of the main end-users of anti-corrosive materials that also issue accurate statements.

## 1 Introduction

Analysis of the current state of innovative development of the Russian Federation and the authors' experience in the design of innovative development programs and models of basic industries (oil and gas industry, energy) shows the relevance of innovation when achieving a high innovation potential of the economy. Under this theme, we should note that commercial enterprises, leading their own innovations not only have effective practices in introducing them to the market, but also provide economic effect [13, 14]. We carried out a study of the impact of innovative development of the Russian company LLC "Antikor". The enterprise's development of corrosion protection of metals exposed to corrosive environments and thermal effects is used to protect metal surfaces and reinforced concrete structures, dead works and bottom of vessels and hydraulic structures, steel structures in industrial atmosphere, gas transportation, production, storage and processing of oil, heat transfer equipment, drinking water supply facilities, food processing equipment, equipment exposed to vibration and vacuum, which are widely used in various industries, such as at

---

\* Corresponding author: [tanmir12@mail.ru](mailto:tanmir12@mail.ru)

nuclear and thermal power plants, chemical and metallurgical plants, ships of various classes, utilities, equipment, water supply and food industry. High chemical resistance of coatings applied to the most common aggressive environment (acids, alkalis, salt solutions, and others.) [15]. Together with resistance to pressure changes and abrasion wear, exposure to vibration and heat, help to protect a variety of surfaces, and industrial machinery, providing it with additional lifetime from 10 to 20 years without implementing process-related maintenance and cleaning of a covered surface during a specified period.

## 2 Methodology

The purpose of this study is to evaluate the total economic impact of anti-corrosion coatings introduced by a group of companies, taking into account the prospects of its activities for sectors of the economy of the Russian Federation. The main problems to be solved in the work are: firstly, to confirm the hypothesis about the effectiveness of the protective properties of corrosion products for metals estimated by the end-users - representatives of industrial enterprises of the Russian Federation; secondly, to estimate economic effectiveness of developing aimed to protect corrosion prevention; thirdly, to evaluate the economic effect of industrial enterprises of all branches of the Russian Federation. Methodical approach to achieving this goal is to measure the direct and indirect economic impact of the group of companies "Antikor" for Russian industries. The direct economic effect refers to the effect received by the companies of national economy, that acquires unique covers of LLC "Antikor" to protect different surfaces and their production equipment. The direct economic effect is based on reducing the cost of protecting and extending the life of surfaces and equipment of the corporate consumers. It is calculated by determining the net present value of the economic effects of corrosion protection. In the process of calculation the average value of direct economic effect for anticorrosion coatings was determined on the basis of 7-8 corporate consumers per 1 sq. m. of the protected surface of equipment per year. In the course of these calculations average value effect equal to \$136 year or about 4080 rubles [1].

The indirect economic effect refers to the following spillover effects.

First point. An effect that is achieved by eliminating the technological losses and downtime of production equipment caused by corrosion. Downtime due to equipment failure, is either completely absent or significantly reduced by using corrosion-resistant coatings. Time needed to produce core products is reduced. This effect is calculated as the cost of goods (volume of services), produced by corporate consumers for the time spent on downtime and loss.

Second point. The effect achieved by reducing the metal content in the industry. The calculation is based on the principle of comparing the effect of alternative methods of surface protection against corrosion of equipment, for example, by using corrosion-resistant metals (stainless steel, copper-nickel alloys, and other special alloys) instead of black metal corrode intensively. This effect is calculated as the value of the volume of non-corrosive metal, which would be sent to the corporate consumers of the anticorrosive coating to protect their surfaces and equipment in case they were not to protect their surfaces and equipment with innovative anti-corrosion coating [5].

Key assumptions and limitations taken into account are as follows: the economic impact is calculated using those industries in which there has been a practical use and application of these coatings.

The economic effect for the period of the actual existence of the enterprise

The economic effect was calculated for the period of the actual existence of the development enterprise (18y.) taking into account the prospects of application in the fields

of enterprise development in the forecast period for the next 4 years. The economic effect was calculated for 4 years.

The economic effect for in post-forecast period

The economic effect in post-forecast period (fifth and subsequent years of the LLC "Antikor") was estimated on the Gordon model, which takes into account only the results of the company achieved in the 4th year of the forecast and the fixed rate of development. [2] This approach stems from the fact that it is difficult to predict the development and identify current trends in this field of science - the development of corrosion protection for the long term. Evaluation of the economic effect was based on cash flow forecasting formed LLC "Antikor" from the proceeds from the sale of protective coatings for a variety of surfaces and equipment.

Basic data for calculation

A basic set of values was set to carry out calculation: the total production of protective coatings of all kinds, the average cost of stainless steel, the average consumption of protective coatings, the annual increase in production of protective coatings, the discount rate, the average annual rate of inflation, the income of the enterprise from the sale of protective coatings. Evaluation of the effect of the forecast period is made in accordance with the methodology for determining net present value (NPV) based on the discount rate. Evaluation of the effect obtained after the discrete projection period made on Gordon model. When forecasting the economic impact for a long-range period, it was expected that the business of LLC "Antikor" would not deteriorate and production volume would remain at the level of production volumes of 2013. Cash flow from the sale of specialized equipment used in the protective coating was not included into the calculation of the effect estimation. Neither was the cash received in the form of royalty payments for research and development, for the received patents, copyrights, etc. As a base for the calculation, the following values were chosen: total production of all types of protective coatings in 2008 was 50 371 kg.; the average cost of stainless steel is 150 rubles. per 1 kg.; the average consumption of protective coatings was adopted in the amount of 1 kg per 1 square meter of treated surfaces; flow rate of 1 kg coatings was equated to about 7 kg of stainless steel; since the beginning of 2010 the forecast of 5% of annual increase in production of protective coatings has been laid; in the post-forecast period it is assumed that the growth rate of total production of protective coatings will reach 3% annually; throughout the forecast and post-forecast periods the discount rate is assumed to be 20%; throughout the forecast and post-forecast the average annual inflation rate is assumed to be 7%; the company will not have any other income other than from the sale of protective coatings; it is assumed that there will be no re-equipment, no substantial acquisition of fixed assets, and no increasing of its own production facilities.[1] In other words, the investment program is not planned. Any capital expenditures will be implemented by means of depreciation charges.

Evaluation of the effect in the forecast period. In accordance with the method used to determine net present value (NPV) of economic benefit, the results were given to the current value based on the discount rate by the formula [6]:

$$NPV = \sum Di / (1+K)^i, \quad (1)$$

where: NPV- present value; Di - the amount of economic benefit obtained in the i-th period of the discrete projection period; K - the discount rate; i - period. Evaluation of the effect in the post-forecast period. Residual economic benefit is the present value of economic benefit obtained after the discrete predicting period. The Gordon model was used to calculate this value:

$$V = DI / (K-G), \quad (2)$$

where: V - the residual value in the fifth year; D1 - the amount of economic benefit obtained in the first year after the end of the discrete projection period; K - the discount rate; G - the expected growth rate of flow. This formula gives a rough estimate of the present value of the future economic benefits at the end of the discrete forecast period, based on a discount rate and a constant growth rate [7].

**Stages of the research**

The logic of the research involves the implementation of the following basic steps. In the first stage opinions and estimates of consumers from various sectors and regions of the Russian Federation were collected and analyzed. In the second stage an examination of existing economic calculations of the development enterprise, and manufacturer of the anti-corrosion technology was performed, taking into account the proposed assumptions and limitations. In the third stage the authors modeled demand and economic benefits for the other metal consumption sectors of the economy of the Russian Federation on the base of data concerning current target consuming industries.

**Research methods**

The source of information is the reporting of the development enterprise producing protective coatings and industrials statistics of Rosstat [3]. Primary information includes estimating of consumers - a group of companies "Antikor" collected through qualitative field research - in-depth interviews [4]. To conduct in-depth interviews it is necessary to obtain estimates of the enterprises of the usefulness of products to enhance the conservation of metal-working equipment. According to the interviews qualitative consumer product evaluation of "Antikor" and commenting statements of research participants were obtained. Questionnaire for in-depth interviews includes questions distributed on three thematic clusters:

- \*efficiency of production equipment for industrial enterprises;
- \*production efficiency for industry in general;
- \*innovative products for the industrial importance of the enterprise on the whole.

This estimation cannot be extrapolated to the entire population of the industrial enterprises of the country, but they give an idea of consumers on a number of problematic issues. The methodology of the studies included a series of in-depth interviews with industrial enterprises, purchasing products [8]. Task Force to make field research included directors of enterprises, experts in technology, production and supply [11, 12].

Use 170 x 250 mm paper size (W x H mm) and adjust the margins to those shown in the Table 1. The final printed area will be 130 x 210 mm. Do not add any page numbers.

**Table 1.** Sample field study.

<b>The company name, of the responden</b>	<b>Industry</b>	<b>The city of the Respondent</b>
1 ANTICOR	Construction, application of anticorpos. coatings	Perm
2 Beloyarsk NPP	Nuclear energy	Zarechny, Sverdlovsk region.
3 LLC "Gazstroytechnica"	Gazprom	Voronezh
4 LLC "Zaporizhzhya nuclear energy company	Nuclear energy	Zaporozhye
5 KuibyshevAzot	Chemical	Kuibyshev
6 Electrocontact	Manufacture and Assembly of printed circuit boards	Novosibirsk

7 JSC "Montajhimzashita".	special construction work.	Moscow
8 LLC "THERMO"	Nuclear energy	Yuzhnoukrainsk
9 LLC "chemical protection-2"	Fitter, chemistry	St. Petersburg
10 LTD. "Jenergozashhita"	Contractors, installation and construction Ref.	Rostov-on-don
11 Of separated subdivision "Yuzhnoukrainsk NPP"	Nuclear energy	Yuzhnoukrainsk
12 LLC "Ecomelectronics"	The power supply	St. Petersburg
13 LTD "Uralspetsavto"	Water treatment, wastewater	Chelyabinsk
14 "Speciments""	Equipment of power plants	Bor, Leningrad region
15 CYS-112	Custom enterprises	Moscow
16 Premigration	TPP	Togliatti
17 LLC "Visit system installation"	Heat transfer equipment	Omsk
18 JSC Atomenergoremont	nuclear power station	Desnogorsk, Smolensk region

Source: a Report on field research [9]

Summary evaluation of the effectiveness of production "Antikor" shows that the majority of the key criteria, representatives of the consuming enterprises give high positive ratings.

**Table 2.** Positive responses enterprises using corrosion products, in%.

<b>Performance</b>	<b>Answers</b>
1. The efficiency for the equipment of industrial enterprises.	
• Increases structural reliability of equipment	94
• Increases safety equipment	78
• Increases the life of the equipment	94
• Improves performance of equipment	44
2. Efficiency for industrial enterprises in General.	
• Increases system reliability	83
• Promotes a safe environment	50
• Affects the production efficiency of the enterprise	89
• Affects economic efficiency of enterprises	83
3. Innovative significance for industrial companies in General.	
• Meets production requirements of the enterprise	89
• Analogues Anticorrosive products on the Russian market - it is the best	60

Source: a Report on field research [9]

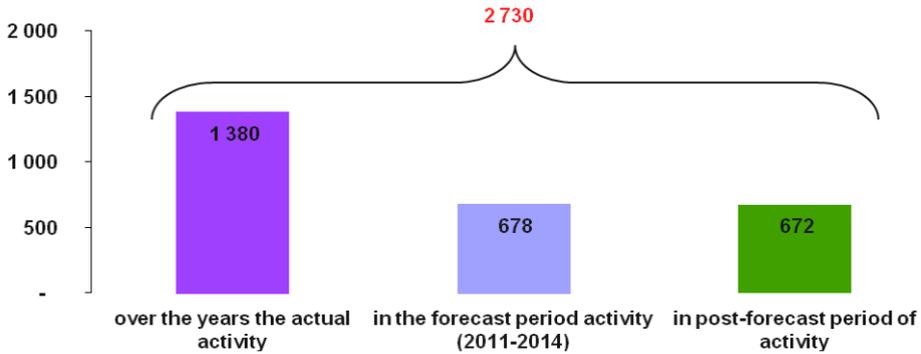
Almost all consumers point the rise of structural reliability of the equipment from the use of anti-corrosion products. Estimated consumer's structural reliability is increased by 50-70% on average, life of some types of equipment increases by 4-5 years. Almost three-quarters of consumers point the rise of production safety of equipment, which is to increase from 50% to 150%. The equipment works more reliably, requires fewer repairs. Almost all consumers point the increase of life of the equipment, since the service life increases to 50-80%. Less than half of consumers point the increased productivity of equipment and more than half believe that performance is maintained at the required level. Such factors as thin layer increase the degree of utilization of the working volume of the process equipment. Most users report about the increase of the system reliability of equipment, which increases by 50-80% on average. Equipment becomes more manageable, easier to identify the planned mode of production, requires less changeovers. Half of consumers point the improving safety of equipment for companies' environment up to 40%. The vast majority of consumers point the improving of the overall production performance of enterprises, as production increases at the expense of ensuring stability. The average increase in production efficiency can reach 10-15%. For example, it is possible to apply thicker layers of protective coatings; it is possible to increase the shelf life of the equipment and the complexity of such works. This technology also reduces labor costs, saves time for preparation equipment. Most consumers point the increasing of the economic efficiency of the enterprise to 5-10%. Extension of the service life of equipment reduces both the frequency and the cost of repair and commissioning. In nuclear power industry efficiency is the highest, because relatively inexpensive protective materials can be used, annual repair the equipment is not necessary, and the turnaround time can be increased to 5-10 years. According to most customers, this innovative technology meets the requirements of industrial enterprises, as the plating technology is very comfortable, even though it is specific. At this point - it is the only product in Russia, which provides increased corrosion protection. Nearly two-thirds of consumers point the absolute leadership in quality of this technology on the Russian market. Based on the above advantages of coatings and materials were evaluated economic effect of their application to various sectors of the economy of the Russian Federation was calculated.

## **3 Discussion**

### **3.1. Evaluation of direct economic effect**

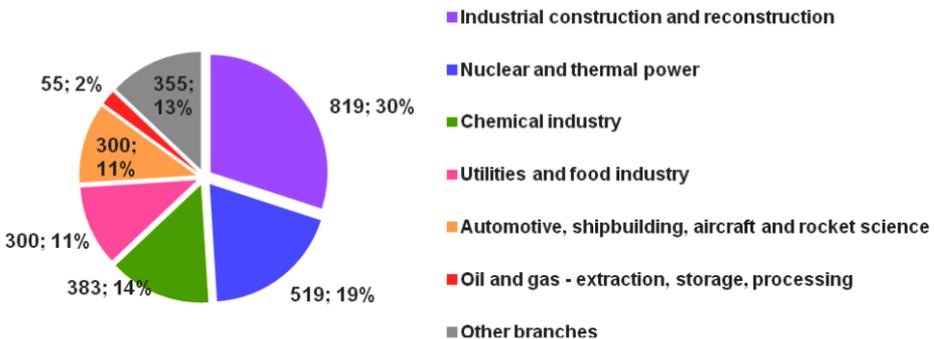
The direct economic effect of the introduction of unique anti-corrosion coating for operating period of the enterprise (18y.) amounted to 1 380 130 000 rub.

The direct economic effect of the introduction of unique anti-corrosion coatings in the forecast period of the company is estimated to be 677,560,000 rub. The direct economic effect of the introduction of unique anti-corrosion coatings in post-forecast period of the company is estimated to be 672,116,000 rub.



**Fig. 1.** The volume of direct economic effect from the use of products LLC "Antikor" in the Russian Federation, in mln. Rub.

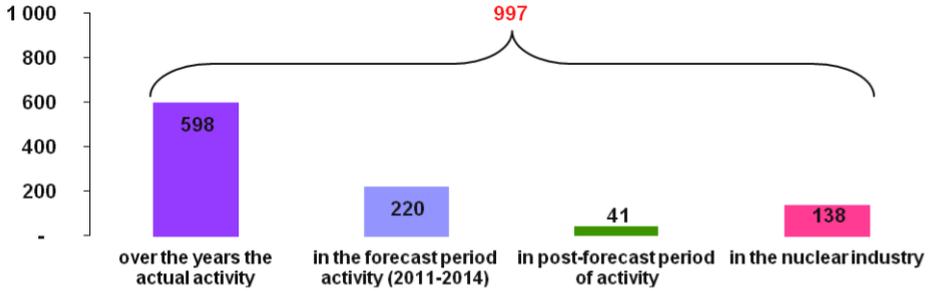
Thus, the total direct economic effect of the introduction of unique anticorrosive coatings is estimated to be 2 729 800 000. Rub. Assessing the impact of direct economic effect from the introduction of protective coatings LLC "Antikor" was carried out in the following industries.



**Fig. 2.** Structure of the direct economic effect from the use of products "Antikor" by economic sector of the Russian Federation, in mln. Rub.

### 3.2 Evaluation of epy indirect economic effect

Indirect economic benefits by reducing metal consumption the total indirect economic benefits of the company by reducing the metal content following the introduction of the unique anti-corrosion coatings is estimated to be 859,380,000 rub. Evaluation of indirect economic effect by reducing metal content: from the introduction of anti-corrosion coatings for operating years of the company amounted to 598,210,000 rub.; in the forecast period the effect is estimated to be 219.8 million. rub.; in the post-forecast period the effect is estimated to be 41.37 million. Rubles



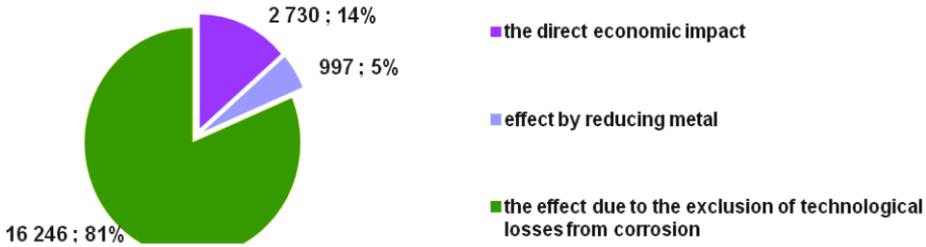
**Fig. 3.** Volume of indirect economic effect by reducing metal content from the use of products "Antikor" in the Russian Federation, in mln. Rub.

Reducing metal content by economic sectors can be described through the following industries-specific features: in nuclear power industry by increasing the life in 1.5-2 times the cost of copper, nickel and, titanium can be reduced by 30-50% in the manufacture of heat exchange equipment. For example, by applying a composite polymer anticorrosion coating at the Leningrad nuclear power plant, the saving of copper-nickel alloys MNZH-5-1 for a period of three years made 138 million. rub. The work for corrosion protection and recovery of heat exchange equipment is extremely effective. The use of new materials allows obtaining an indirect effect due to the exclusion of technological losses. [Compiled by the authors]

**Table 3.** The indirect economic impact due to the exclusion of process losses.

Industry	direct economic impact, mln.rub	effect from the reduction of losses		the effect of the increase in electricity generation	
Industrial construction and reconstruction	818.94				
Utilities and food industry	300.28				
Automotive, shipbuilding, aircraft and rocket science	300.28				
Chemical industry	382.17	4.2%	16.05		
Oil and gas - extraction, storage, processing	54.60	5.6%	3.06		
Nuclear and thermal power	518.66	3.1%	16.08	8%	41.49
Other branches	354.87				
<b>Total</b>	<b>2729.80</b>		<b>35.19</b>		<b>41.49</b>

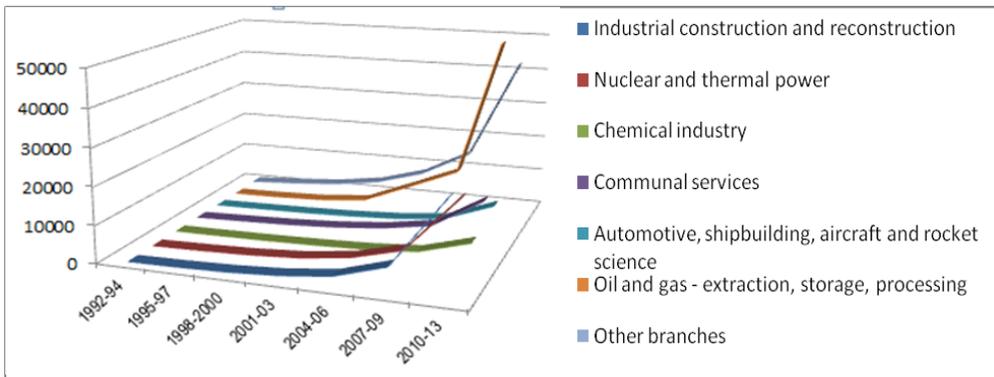
Thus, the application of protective coatings can significantly reduce or eliminate the technological losses and downtime, allows to implement new advanced technologies and get the total economic impact of \$ 16 245, 68 mln. Rub. You also need to take into account the effect of the introduction of new advanced products and technologies that make it possible to implement innovative projects, in particular - the submarine project Amur-1650 with modern habitable spaces of high purity; construction and equipment of factories for the destruction of chemical weapons; electrophoresis painting line newly built car factories in Russia foreign manufacturers. The total economic impact of the introduction of anti-corrosion coatings LLC "Antikor" during the existence of the enterprise, as well as the prospects for its activities (medium-term) is 18 975 480 000 rub.



**Fig. 4.** Structure of the total economic impact of the introduction of anti-corrosion coatings LLC "Antikor" in the Russian Federation, mln. Rub.

According to estimation of the enterprises surveyed, the savings on running repairs in the case of using anti-corrosion materials can reach 5 - 10%. One of the main end-users of anti-corrosive materials that also issues accurate statements (as compared with the construction industry) is energy industry. To estimate the costs of current repairs of fixed assets, data on Leningrad NPP were taken. For example, in 2012 it was spent nearly 90 mln. Rub for repairing [2]. Then, these expenses are extrapolated for the volume of electricity to other nuclear power plants of Russia, as well as to heating plants. Thus, the average savings on current repairs on the nuclear power plant in 2012 was about 40 million Rub. While for thermal plants it was about 252 million Rub. Total saving of the energy complex made 292 million Rub. Then, based on the calculated value the economic effect of using anti-corrosion materials is designed through the indicator of production volumes for other branches of the Russian Federation, estimated in this paper.

The total economic effect from application of anti-corrosive materials by economic sectors in Russia during the analyzed period from 1992 to 2013 is estimated at 271 238 million Rub.



**Fig. 5.** Assessment of economic effect from application of anti-corrosive materials for various industry of the Russian economy, mil. Rub.

## 4 Conclusion

Results of the assessment of the economic efficiency of innovative anti-corrosion coatings for the economy of the Russian Federation was based on methodology for determining the present value (NPV), estimating the economic benefit results was based on the discount rate. Evaluation of the effect obtained after the discrete projection period was made on the Gordon model. First of all, it is clear that economic effect from application of anti-corrosive

materials for various branches of the Russian economy includes direct and indirect economic effect. In this study, the forecasting of the economic efficiency of anti-corrosion technologies for Russian economy is based on allocating common features of increasing the efficiency of operations and maintenance activities of industries, forecasting development and ongoing assessment of consumer's product and calculating the direct and indirect economic effects.

## References

1. *Internal reporting LLC «Antikor»* (2013)
2. *Marketing agency LLC «Business-Class», Report on a field research* (2013)
3. M. J. Gordon, *The Investment, Financing and Valuation of a Corporation* (Conn.: Greenwood, Westport, 1982)
4. Federal State Statistics Service (Rosstat). Information on <http://www.gks.ru>
5. Ministry of Chemical Industry of the Russia, *Method of determining the annual economic effect on the creation and implementation of new technology, inventions and innovations in the chemical industry* (1978)
6. A. Damodaran, *Investment valuation. Tools and methods for the evaluation of any assets*( Alpina Publisher, Moscow, 2011)
7. Fisher, *The Theory of Interest* (Macmillan, New York, 1930)
8. N.K. Denzin, Y.S. Lincoln, *Handbook of Qualitative Research* (Sage Publications, London, 2000)
9. N.L. Kuchugin and other, *Marketing on the notes: a practical course on Russian examples* (Moscow, Market DS, 2008)
10. T.K. Miroshnikova, N.L. Kuchugin, *Procedia Economics and Finance*, **15**, 426-434 (2015)
11. K.M. Eisenhardt, J.A. Martin, *Strategic Management Journal*, **21(10-11)**, 1105-1121 (2000)
12. C.E. Helfat, M.A. Peteraf, *Strategic Management Journal*, **24(10)**, 997-1010 (2003)
13. R.M Grant, *Strategic Management Journal*, **17**, 109-122 (1997)
14. R. Gulati, *Strategic Management Journal*, **19(4)**, 293-317 (1998)
15. C. Freeman, L., *Soete, The Economics of Industrial Innovation* (London, Pinter, 1997)