Innovative Businesses in Russian Science Cities

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Abstract: The paper aims to investigate the innovative activity of companies located on the territory of the co-called science cities with their unique research environment. The hypothesis of the discrete role of these cities in the development and formation of the country innovation system is also checked in the study. With this purpose, the holistic analysis of the innovation activity of the science cities is made, and the comparison with the national data is drawn. To accomplish this, we use various characteristics of innovation process which show both its inputs and outputs. The level of companies' involvement in innovation process is also investigated as well as the innovation costs structure. The costs of in-house R&D, production design, personnel training and the costs of marketing research are analyzed among the others in the paper. The cost structure of technological innovation depending on the financial source is also considered. In particular, we study the ratio of firms own costs on technological innovation to budgetary financing. Their industry affiliation is considered as a crucial factor which determines firm's innovation activity. For this particular reason, we analyze the company's innovation process within different industries. The approach offered in the paper allows to estimate the effectiveness of innovation activity of science cities firms in comparison with other national companies and reveal the industries based in the science cities with the much bigger innovation results than others. The further paired analysis of the revealed industries for the studied economic areas and the country in the whole makes it rather possible to establish the factors which slow down the development of the individual branch and identify the opportunities for the breakthrough in innovation process quality.

Keywords: innovation, science city, innovation process, Russia, innovation behaviour

1. Introduction

Under the current conditions, innovation and development of Russian enterprises and industry are one of the top national priorities. On the governmental and scientific levels of society, these issues are taken into account as well. The particular attention is paid to the basic development of national innovation system capable to securely provide the high quality of economic growth and organize the comprehensive interaction between both economic environment and the environment making knowledge (research and higher education institutes).

Despite the avowed importance of the country transition to the innovative development path and moves, the innovation activity of Russian companies still leaves something to be desired (Golichenko and Balycheva, 2015). As a result, sales of innovative products as a proportion of total turnover amount to 5-7% and 9-15% as a proportion of the turnover of innovative firms. No remarkable improvements have been observed over many years. On top of that, companies often drop innovating or begin using less complex forms based, for example, only on the diffusion of innovative products already known on the market. It is essential to develop the system elements both inducing companies to innovation activity and creating conditions for its realization. The municipal units with high scientific and technological potential or science cities can be considered as one of the elements of forming national innovation system. A necessary part of research and technology potential is located in these cities.

Focused on a separate branch the science cities were created in the USSR throughout many decades. They have always aimed at the development of new technologies and had close ties with the industry. Such cities with high intellectual, scientific and technical capital were created around the big cities which were the regional educational centers with the considerable concentration of intellectual resources. At present, the official status of science city of Russian Federation is given to 14 municipalities. It is to be underlined that their status was given according to the Federal Law. The municipal formation applying for the assignment of the science city status has to possess the scientific and production town-forming complex matching specific criteria (Karpenko, 2019).
Nowadays many science cities are able to perform scientific research, develop advanced technologies and conduct innovative activity at a high level as well as produce the competitive product using highly-qualified human resources and developed physical infrastructure (Glisin et al., 2011a, Orlov and Shelegina, 2019). Moreover, the comparison of national and science cities indicators demonstrates the integral competitive advantages of the latter (Barsukova and Dorofeeva, 2015). However, some authors note that in spite of the considerable technological capacity, many science cities barely adjust to modern economic paradigm (Glisin et al., 2011b). This primarily occurs because the final products of science cities were aimed mostly for defense strategies, thus the results of their activities were not supposed to be associated with the use of new knowledge for business purposes. The aim of the study is to analyze the innovation activity of Russian science cities and to test a hypothesis of their possible discrete role in the development and formation of the country innovation system.

2. Data and research method

The data used in the study were provided by Russian innovation surveys dated 2013 - 2015. The companies data were collected from a random sample based on the Federal State Statistics Service database including industrial sectors numbered 15-37 and service sectors numbered 72-74. The database includes more than 35000 firms. The questionnaire was sent out to the managers of these firms aiming to identify their innovation activities. With the aim of analyzing the strategies of companies located in the science cities we also use the special innovation surveys of science cities innovation activity. In these surveys, firms are divided into industrial groups. The firms were asked to complete a questionnaire that addresses their innovative activities. This questionnaire yields information on many innovation indicators used in the study.

In the first stage of the study, the comparison was drawn between economic and innovative activities of science cities with all-Russian indicators. The sectoral structure of industry of the considered cities and its connection with the sectoral innovation structure are analyzed. The level of science cities companies involvement in the innovation process and the efficiency of their innovation activity are evaluated. In the second stage, the branches which innovative results significantly exceed the average national indexes are revealed. Afterward, a more precise test of the innovation activity of such industries is made. Furthermore, the comparison with other national companies of these branches is drawn. We also consider the cost structure of technological innovation and identify the most significant factors promoting the increase in the innovative activity of science cities. In addition to it, the source of innovative projects financing is investigated.

3. Innovation activity of science cities

The population of science cities makes less than 1% of the nation. The general cities contribution to the shipped volume was 0,61% in 2015 and 4,7% to innovative volume. In the sectoral structure of Russian science cities the branches connected with providing the defense capability of the country mostly prevail. Around 29% of the total volume of shipped products are associated with the processing of nuclear fuel, manufacture of explosives, weapons, and ammunition (see Figure 1A). Such situation is obviously originated due to the historical background. The majority of science cities was created in the 30s, 50s, and 70s targeting the efficient development, scientific research and technology support of military and industrial sectors (Kyznezev, 2014).

Along with mentioned-above sectors, the contribution of the companies engaged in the chemical production as well as in electrical and optical manufacture is significant. Their share of products makes 15% of the total volume of the science cities.

The sectoral structure of innovative industry highly differs from the general structure (see Figure 1B). In this case, the greatest contribution to the total volume of shipped innovative products is made by the firms engaged in the manufacture of fabricated metal products. It equals to 44% of the total volume of innovative products in spite of the fact that its contribution into the general sectoral structure stands at 9%. One more branch, which displays the wider contribution to the innovation products than to the total production is the manufacture of textiles and textile products.
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Figure 1: The sectoral structure of industry (1A) and the sectoral structure of innovation industry (1B) of Russian science cities in 2015.

The innovative activity of science cities companies surpasses the average national level. The share of innovative products among all sales was 18-21% during the period 2013-2015. It outnumbers the all-Russian indexes more than twice. It is worth noting that in different time periods such spread is attained by means of innovation activity of companies from different branches. For instance, in 2013 it was provided due to innovation activity of firms engaged in the manufacture of furniture, machinery and equipment and companies producing food products and beverages. In 2014, the companies of the following branches remarkably exceeded the national indicators. They were the manufacturers of electrical equipment, medical products and devices, food products and beverages. Meanwhile, in 2015 the greatest difference with the national level of innovativeness was displayed by the companies making the fabricated metal products and textile production.

From this perspective, in spite of large-scale distribution of innovative products of science cities companies, there are considerable fluctuations in their volume, which can depend on both external factors (Ernst and Young, 2012; Andreev, 2011; Malysheva and Shestakov, 2012) and the stage of the innovative cycle (Golichenko 2014).

It is vital to emphasize that the distribution level of innovative products relating to high technology and middle-high technology industries considerably falls behind the average national indicators. Among other things, exports of products in high-technology industries of science cities are at a rather low level and make 3% for all production and 2% for innovative production. The average all-Russian indicators are 22% and 17% respectively.

The considerable volume of innovative products (40%) of science cities companies was shipped outside the country in 2015. In comparison, the average national indicator is 24%. Within the studied period, the considerable growth in export of innovative products of science cities companies from 8% in 2013 to 40% in 2015 is observed. Despite this, the export of innovative products in the countries of Former Soviet Republics decreased from 8% to 1%. Considering this, the indicator growth takes place by means of products export to the far abroad. The analysis shows that such situation has arisen as a result of the noteworthy expansion in the export of innovative products of companies engaged in the manufacture of fabricated metal products. In addition to it, within the studied period, there was an increase in the product supply to the far abroad by firms making textile products, machinery and equipment, furniture and other non-grouped production. For some companies, the decrease in the export of innovative products is observed during this period. It is the enterprises engaged in the manufacture of food products and pharmaceutical products.
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Table 1: The innovation indicators depending on the industry

|                               | Sales of innovative products (% of total turnover) | Export of innovative products (% of total innovative products) | Export of all products (% of total turnover) |
|-------------------------------|---------------------------------------------------|---------------------------------------------------------------|---------------------------------------------|
|                               | Science cities | Russia | Science cities | Russia | Science cities | Russia |
| Total amount                  | 19%            | 8%     | 40%            | 24%    | 17%            | 21%    |
| Manufacturing activity        | 20%            | 11%    | 40%            | 22%    | 17%            | 24%    |
| High-technology branches      | 12%            | 13%    | 0%             | 16%    | 3%             | 17%    |
| Manufacture of electronic components and boards | 12% | 13% | 0% | 16% | 3% | 17% |
| Drug manufacturing            | 9%             | 11%    | 17%            | 1%     | 13%            | 8%     |
| Manufacture of medical devices | 34%            | 21%    | 0%             | 1%     | 6%             | 6%     |
| Middle-high-technology branches | 7%             | 14%    | 12%            | 13%    | 24%            | 19%    |
| Chemical manufacture          | 8%             | 9%     | 14%            | 29%    | 26%            | 38%    |
| Manufacture of machinery and equipment | 17% | 5% | 9% | 5% | 8% | 6% |
| Middle-low-technology branches |                               |                                                  |                                             |
| Manufacture of rubber and plastic products | 5% | 10% | 0% | 2% | 1% | 4% |
| Manufacture of fabricated metal products | 92% | 5% | 83% | 40% | 78% | 6% |
| Manufacture of products and metals which are not included in other group | 14% | 17% | 5% | 33% | 14% | 27% |
| Low technology branches       |                               |                                                  |                                             |
| Manufacture of food products  | 6%             | 4%     | 3%             | 35%    | 7%             | 5%     |
| Textile manufacture           | 58%            | 6%     | 14%            | 6%     | 8%             | 5%     |
| Manufacture of furniture      | 13%            | 1%     | 6%             | 16%    | 6%             | 16%    |

Consequently, the essential characteristics of innovative activity of science cities companies are reached not by virtue of high-technology industries development requiring considerable investment in research and development and availability of well-qualified personnel but by means of low- and middle technology industries. In the mentioned branches, the innovation activity can be based on acquired intangible or practical knowledge (Heidenreich, 2009), as well as on formal or informal idea diffusion between companies (Jacobson and Heanue, 2005). Innovations appear here rather as a result of the incremental development of products and technologies. Pull of demand (requirements from consumers) or evolutionary optimization of production technology is a conventional basis for this innovation activity (Hirsch-Kreinsen, 2008). In the terminology used by Lundvall and Johnson (Lundvall and Johnson, 1994), the following significant sources of innovative activity also have to be taken into account (Heidenreich, 2009): «learning-by-doing, learning-by-using, learning-by-interacting, learning-by-producing, and learning-by-searching».

It is remarkable that in the scientific literature the development of high-technology branches is considered as the primary function of science cities in innovation activity. This activity level is not high, though.

After the detailed analysis of the innovative activity of science cities companies demonstrating the high quality of the process is made. It allows to reveal the drivers which affect the innovation process the most. Also, the research of innovation process of high and middle-high technology companies is conducted for the factors identification which limit the innovation process in these natures of businesses.

4. Specification of companies innovation process

4.1 High-technology branches

The development of high-technology businesses is often considered to be the main function of science cities.

The effectiveness of innovation activity of these businesses is yet below the average national level (see Table 1). The costs of research and development on new products, services and production methods and the costs of machinery and equipment prevail in the costs structure of technological innovations. The notable difference between innovation process of science cities high-technology companies with other Russian high-technology firms lies in the much smaller tendency to technology acquisition, especially in disembodied form. It is also possible to mention that science cities companies are less involved in innovation processes. More than 30% of
Russian high-technology companies introduced technological innovations in 2015, the similar indicator for science cities did not exceed 25%. Besides, almost exclusive orientation of high-technology enterprises of science cities on the domestic markets took place. Only 3% of shipped products and 2% of innovative products were exported. For other high-technology firms in the country these indicators equal to 17% and 22% respectively.

The exception is the science cities companies engaged in the manufacture of medical devices, measuring equipment, optical instruments, watches. The sales of innovative products are more than 34% of total turnover for these firms, which is 13% more than the average national level. On top of that, the situation is observed for the whole studied period, the distribution of innovative products of science cities companies significantly exceed the average all-Russian indicators for this activity type. It is also to emphasize that there are various factors exerting the greatest impact on the innovation process of science cities and other territory companies. The basis of innovation activity of science cities companies is the introduction of new products by means of in-house research and development. As many as 87% of costs on technological innovations are accounted for the research and development of new products, services and production methods. The other significant factor of innovation activity is the process of engineering, which includes the preparation of technical and economic evaluation, production design, pilot production and testing, hook-up and commissioning. As opposed to science cities companies, other Russian firms of these businesses are less intensive in research activities. In addition, these science cities companies are more involved in the innovation process in comparison with others. The share of the former engaged in technological innovation makes around 33% whereas for the latter it equals to 28%.

In spite of the fact that science cities have many-year experience not only in conducting the fundamental research (Tuzkova, 2015; Gatsko 2015) but also in the development and manufacturing of high-technology products (Akinfeeva and Abramov, 2015), in most cases, the distribution of these products is not widespread. Having significant research potential, not all enterprises are capable of using it efficiently for economic purposes.

4.2 Middle-high-technology branches

The distribution of innovative products of science cities middle-high-technology companies is significantly lower than among other middle-high-technology Russian firms. In 2015, the share of innovative products was 7%, which was more than two times less than the average national indicator. Over and beyond that, this difference was even more significant in 2013 and 2014. By contrast with science cities high-technology branches, innovative products export almost equals to all-Russian ones, and all products exports exceed the country average level in 1.3 times. Most likely, the quality of innovative products of science cities companies is relatively high which allows them to compete with other producers. Yet, the costs structure on technological innovations is remarkably different for science cities and other Russian companies belonging to the middle-high-technology branches. To a maximum of 82% of costs on technological innovations is accounted for research and development of new products, services and production methods. Although during the studied period the value of this indicator varied within 30%, it significantly outweighed the average country indicator ranging between 16% and 26%. Similar to science cities high-technology companies, middle-high-technology ones do not tend to acquire machinery and equipment related to innovations. Within the three-year period, about 8% of costs accrued to this expense item among science cities companies whereas the average national indicator among similar companies equaled to 44%. The current situation is associated with the special features of innovation process of science cities firms. In particular, companies are focused more on the process but not on product innovations.

The representative of middle-high-technology businesses with a different model of innovative behavior is the nature of business related to the manufacture of machinery and equipment. The distribution of innovative products is three times higher among science cities companies than among others. What is more, the exports of all products and innovative ones are also higher for science cities companies. In this case, the main factors determining the innovation process are the conduction of research and development, machinery and equipment acquisition, staff training. In contrast with science cities companies, others tend to staff training to a much lesser degree.

It is important to note that both high- and middle-high technology companies of science cities do not incline to intensive participation in the processes associated with production design. Taking into consideration that the
costs of machinery and equipment are also very low in the majority of cases, it can be assumed that companies do not implement their innovations to the fullest extent. Due to the fact that research and development of new products, services, and production methods are the basis of their innovation activity, it is conceivable that there is a transfer of intellectual property from science cities companies to the enterprises located outside these territories. Among other factors, the situation can appear as a result of the lack of capability of the created innovations implementation. These difficulties are likely to originate in financial restrictions or insufficient links between environment producing knowledge and direct manufacture of innovation products.

4.3 Middle-low-technology branches
The specification of innovation process of middle-low-technology businesses depends most commonly on the particular economic activity. The science cities companies are primarily involved in the following nature of companies: manufacture of rubber and plastic products, manufacture of fabricated metal products and manufacture of explosives, weapons, and ammunition.

The highest efficiency of innovation activity is observed for science cities firms engaged in the manufacture of fabricated metal products. During the period researched, the share of innovative products increased from 4% to 92%. In the same period, there was a growth in export of innovative products - more than 80% of these products were shipped outside the country. Apparently, these changes took place due to the intensive international corroboration. The basis of the innovation process in this period was the exclusive orientation on product innovation. In the costs structure of technological innovations prevails the costs of machinery acquisition and production design. Under these circumstances, the financing of innovation activity comes only from the equity capital. It is also possible to highlight that these science cities companies are significantly involved in the innovation process. Around 27% of companies engaged in the manufacture of fabricated metal products had technological innovations in comparison with the average national indicator which equals to 9%.

4.4 Low-technology branches
The innovative behavior of the group of low-technology businesses is characterized by significant variability. Most likely, it results from the specific nature of activity when the changes of innovative behavior cannot require the significant investment. In spite of the fact that for innovations in low-technology branches the availability of great research potential and investment in R&D are not so crucial as for high-technology businesses, the science cities low-technology firms display remarkable efficiency in the innovative process.

The basis of innovation activity of companies engaged in textile manufacture is the launch of new innovative products. The distribution of these products is widespread and makes 58%. It surpasses the average all-Russian level among similar companies in ten times. The export of innovative products is also higher than the average and makes 14%. The companies intensively use product innovations modifying the innovation process at the same time. The costs of production design and machinery and equipment related to innovation are significant.

As opposed to the average indicators, the innovation activity of these science cities companies is essential: around 43% of textile companies possessed innovations in 2015. The similar national index equaled 11%.

5. Conclusions
In spite of the fact that science cities are able to perform scientific research, develop advanced technologies and conduct innovative activity at a high level, the majority of high- and middle-high technology businesses companies do not implement their innovations to their fullest extent (Samovoleva and Golichenko, 2014). The basis of their innovation activity is research and development of new products, services and production methods. Yet, in many cases, they tend to transfer their intellectual property to others which are able to commercialize it. Among other things, the situation can appear as an outcome of financial restrictions or insufficient links between environment producing knowledge and direct manufacture of innovation products.

As opposed to high-technology businesses, some representatives of low-technology branches demonstrate extraordinary innovation activity and remarkable efficiency in the innovative process. Thus, it is crucial to design a mechanism of the completest use of the potential of science cities to the development of innovation economy by means of companies stimulating of their created innovations implementation. With the aim of preservation and intensive use of science cities research and technological potential, it is necessary to provide their productive inclusion in the economic environment and identify its role in the national innovation system.
Taking into account the fact that one of the primary functions of science cities is the development of research potential and its use for innovation creation, it is not unreasonable to consider science cities not only as independent municipal formations but as essential elements of the country innovation system.

References

Akinfeeva, E.V., Abramov V. I. (2015) “The role of science cities in the development of the national innovation system in Russia”, Studies of Russian economic development, 1(26), pp. 91-99.

Andreev, V.V. (2011) “Nekotorye factory, zatrudnyayuschie realizaziyu innovacionnogoo razvitiya rossiyskoy economiki i povysheniya ee konkurentosposobnosti”, http://innclub.info/2011/11/08/некоторые-факторы-затрудняющие-реал/

Balycheva Y., Golichenko O. “The innovation process of Russian manufacturing companies”, Proceedings of the 10th European Conference on Innovation and Entrepreneurship, pp. 45-53.

Barsukova, N.E., Dorofeeva N.S. (2015) “Sovremennoe sostoyanie I perspektivy razvitiya nauchno-proizvodstvennykh kompleksov naukogrados Rossijskoy Feferazi: analiticheskiy obsor”, Vestnil TvGU. Seriya "Economika i upravlenie", pp. 192-204.

Ernst and Young (2012) “Barametr predprinimatelskoy deyatelnosti”, http://www.ey.com/Publication/vwLUAssets/entrepreneur-speak-out-2012-ru/$FILE/entrepreneur-speak-out-2012-ru.pdf

Gatsko, M.F. (2015) “Research campus and innovative regional cluster of Moscow region as a factor of socio-economics development of the region”, Nauchniy vestnik 2(4).

Glisin, F.F, Kolzov, A.V., Razin, V.L., Habarova, T.L. (2011a) “Naukogrady Rossiю kak tochki innovazionnogoo rosta”, Informazzano-analiticheskiy bylluten ZISN.

Glisin, F.F., Razin, V.L., Habarova, T.L (2011b) “Naukogrady v sovremennoy economike Rossiю”, Innovazi 2, pp. 71-76.

Golichenko, O.G. (2014) “The Relationship Between Patents and Firms’ Innovation Activity: The Case of Russia”, Proceedings of the 9th European Conference on Innovation and Entrepreneurship – ECIE 2014, University of Ulster and School of Social Enterprises Ireland Belfast, UK 18-19 September 2014.

Heidenreich, M. (2009) “Innovation patterns and location of European low-and-medium-technology industries”, Research Policy 38, pp. 483-494.

Hirsch-Kreinsen, H. (2008) “Low-Tech’ innovations”, Industry and Innovation 15(1), pp. 19-43.

Jacobson, D., Heaneu, K. (2005) “Implications of low-tech research for policy”, Low-Tech Innovation in the Knowledge Economy, pp. 315-331.

Karpenko V.O. (2019) “Osobennosti organizacii mestnogo samoupravleniya v naukogradah”, Vestnik sovremennyh issledovanii, 2019, 1.4, pp.38-41.

Kuznezov, M.I. (2014) “Russian science cities: concentrating intellect for development of science and high technology industries”, Naukograd nauka prizvodstvo obzhestvo 2, pp. 5-19.

Lundvall, B.-A., Johnson B. (1994) “The learning economy”, Journal of Industry Studies 1(2), pp. 23-41.

Malycheva, L.A., Shestakov, I.V. (2012) “Analiz podhodov k ozenke innovazionnoy aktivnosti rossiyskih predpriyatiy” Vestnik PNIPU. Sozialno-economicheskie nauki 2012 №1(38).

Orlov S.B., Shelegina O.N. “Science Cities in Siberia: historical sociological analysis”, Innovatika I Ekspertiza, 1 (55), pp.155-165.

Samovoleva, S., Golichenko, O. (2014) “The Analysis of Business Preferences to use Internal and External Sources of Research and Development”, Proceedings of the 9th European Conference on Innovation and Entrepreneurship ECIE 2014, University of Ulster and School of Social Enterprises Ireland Belfast, UK, 18-19 September 2014, pp. 216-24.

Tuzkova, D. K. (2015) “Razvitiye naukograda kak elementa regionalnoy innovazionnoy systemy Moskovskoy oblasti”, Servis v Rossii i za rubezem, 9, 4(60), pp. 92-101.

Голиченко, О.Г., Балычева, Ю.Е. (2015) “Зависимость инновационных стратегий российских предприятий от степени технологичности производства: структурный и динамический аспекты”, Инновации № 1 (195), c. 53-65.