

**INNOVATION DEVELOPMENT SECTORAL TRAJECTORIES OF THE
SOUTH RUSSIAN REGIONS**

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Abstract: The paper investigates the technological trajectories of innovation-based development of the South Russian regions. It has been determined that cost sharing in technological innovations and innovation activities depends on the types of sectoral trajectories. The statistical data have shown that at the modernization stage import of technologies must become the basis for further development. Supplier-dominated and scale-intensive sectors can be characterized as imitators while science-based sectors as innovators in the sphere of knowledge economy.

JEL Codes: O30, O31, R1

Key words: sectoral trajectories, innovation, intellectual potential, research intensity, sources of technologies, technological development, Russian regions

1. Introduction

Current development of Russia's economy demands modernization of economic systems at macro-, meso-, and micro levels and is characterized by intellectualization, informatization and technologization that promote intellectual potential development of Russian regions. In this paper we estimate and analyze the intellectual potential of the South Russian regions and investigate how knowledge influences sectoral innovation specialization of the South Russian regions.

According to some Western studies various sectors have their own inherent models of innovation development that determine sectoral differences in technology sources. E. Vieira, E. Vazquez-Rozas and I. Neira emphasized the importance of the innovation input in the productive process as a way to maximize the capacity and effectiveness of the labour factor and its productivity. They described some of the factors that are enunciated and that condition the existence of good levels of productivity of the factor work, enhancing with special attention the narrow relation between innovation and productivity. The authors used an econometric model (E. Vieira, E. Vazquez-Rozas, I. Neira, 2008).

J. Tidd, J. Bessant, K. Pavitt and M. Dodgson proposed five technological trajectories characterized by different sources of innovations and technologies (supplier-dominated sectors, scale-intensive sectors, specialized suppliers sectors, science-based sectors, information-based sectors) (Tidd et al., 2003; Dodgson, 2000). We focus on the sources of technologies typical of different sectors of the economy in order to identify technological specialization of the South Russian regions.

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2. Materials and methods

The intellectual potential development index is used as a main tool for analysis. The index is based on the five indicators: the number of university students per 10,000 people (university graduates indicator); employed population structure in terms of education level (education level indicator); the number of post-graduate students per 10,000 employed (academic staff indicator); the number of R&D personnel per 10,000 employed (R&D employment indicator); the share of internal current R&D expenditure stated as a percent of the Gross Regional Product (research intensity indicator) (Report on human potential 2004, p. 107-108).

For the analysis we use the following minimum and maximum values: 200 and 550 for the university graduates indicator; 0 and 100% for the education level indicator; 0 and 30 for the academic staff indicator; 0 and 100 for the R&D employment index; 0 and 2% for the research intensity index.

The intellectual potential development index is calculated as an arithmetical mean value of the indices of the five above mentioned indicators any one of which is calculated by using the following formula (Antonenko 2009, p. 13):

$$\text{Index} = (\text{fact} - \text{min}) / (\text{max} - \text{min}),$$

where *fact* means actual value, *min* and *max* – minimum and maximum values of the indicator.

Using this formula the indices are brought to their relative levels, i.e. they are normalized before averaging in order to put them in the unified measurement scale. Thus, the intellectual potential development index includes five components and is calculated using the arithmetical mean formula of the five indices which means the equality of the components of the intellectual potential development.

Statistical method is used to calculate the share of costs for technological innovations in the South Russian regions, to identify science-based sectors, and to calculate the share of R&D costs in the technological innovation cost structure.

Functional-analytic approach allows to interrelate the technological trajectories, i.e. supplier-dominated sectors are characterized by the lack of in-house technologies needed for the development and by the need to improve the modes of production and search for new technologies for better competitiveness. Scale-intensive sectors are characterized by the purchase of new technologies and equipment from foreign firms resulted in restraint of demand for R&D results in Russia. With regard to the competitive advantages of Russia's science-based sectors, they are not significant and business development rate is restrained by extremely competitive foreign firms and long technological cycle. In specialized suppliers sectors it is necessary to develop in-house finished software due to sufficient human and intellectual resources and competitive advantages.

3. Data analysis

In terms of the university graduates the Rostov region, the Stavropol region, and the Republic of North Ossetia-Alania take leading positions; the Republic of Adygea, the Republic of Dagestan, the Astrakhan region, and the Volgograd region can be characterized as relatively good; the group of depressive regions includes the Republic of

Kalmykia, the Karachay-Cherkess Republic, and the Krasnodar region; the Republic of Ingushetia and the Kabardino-Balkar Republic are characterized as crisis regions (Antonenko, 2009).

In terms of the share of employed population with higher, undergraduate and vocational education (the average Russian index is 56.4%), the regions with the index more than 60% are included in group one; 52-60% – in group two, 46 – 52% – in group three, less than 46% – in group four. Thus, the Astrakhan region with 60.4 % is the leader among the South Russian regions in terms of the share of employed with higher education. Group two includes the Republic of North Ossetia-Alania, the Republic of Ingushetia, and the Volgograd region; group three includes the Republic of Adygea, the Republic of Kalmykia, the Karachay-Cherkess Republic, the Krasnodar region, the Stavropol region, and the Rostov region; group four (outsiders group) includes the Kabardino-Balkar Republic, and the Republic of Dagestan (Antonenko, 2009).

Based on the analysis of the academic staff indices of the South Russian regions, we can say that the composition of leaders and outsiders remain relatively the same. The Astrakhan region and the Rostov region take leading positions, whereas the Republic of Ingushetia and the Republic of Kalmykia are outsiders.

Considering the number of R&D personnel per 10,000 employed it should be noted that on average in Russia 133 of 10,000 people were engaged in R&D (Innovative path of development for a new Russia, 2005). According to the Russian standards only the Rostov region with 86 of 10,000 people can be characterized as a region with high R&D personnel index.

The Rostov region is ranked the first among all South Russian regions in terms of this index, the second group includes the Krasnodar region, the Astrakhan region, the Volgograd region, and the Karachay-Cherkess Republic with the index of no less than 30 people per 10,000 employed. The third group includes the Kabardino-Balkar Republic, the Republic of Dagestan, and the Republic of Adygea with the index of no less than 20 people per 10,000 employed; the fourth group includes the Republic of Kalmykia, the Republic of North Ossetia-Alania, the Stavropol region, and the Republic of Ingushetia with the index of less than 20 people per 10,000 employed that shows extremely low level of R&D personnel in these regions.

In terms of R&D expenditure in the GDP Russia with 1.24% took a leading position compared to China (1.12%) and Italy (1.07%), but fell behind Canada in terms of absolute expenditure (14,241ml dollars and 17,358 ml dollars respectively) (Report on human potential development in the Russian Federation for the year 2004, 2004, p. 7-8). Taking into consideration current R&D internal expenditure in the Gross Regional Product, it should be noted that R&D financing is close to catastrophic.

Only Rostov region can be characterized as the region with relatively good R&D funding, whereas the Karachay-Cherkess Republic, the Krasnodar region, the Volgograd region, and the Astrakhan region have indices below the average, the other South Russian regions are considered as crisis regions in terms of R&D funding.

The intellectual potential development indices of the South Russian regions (see Table 1) show that the regions with a great number of higher education institutions, colleges and research institutes (the Rostov, Astrakhan and Volgograd regions) take

leading positions, but most South Russian regions are characterized by low level of intellectual potential.

Table 1. The intellectual potential development index of the South Russian regions, 2006-2012

South Russian regions	University graduates index	Education level index	Academic staff index	R&D employment index	Research intensity index	Intellectual potential development index
Rostov region	0.900	0.478	0.69	0.86	0.645	0.714
Astrakhan region	0.674	0.604	0.693	0.41	0.265	0.529
Republic of North Ossetia-Alania	0.88	0.579	0.723	0.23	0.105	0.503
Volgograd region	0.682	0.536	0.57	0.36	0.21	0.471
Stavropol region	0.871	0.495	0.676	0.16	0.115	0.463
Republic of Adygea	0.782	0.486	0.666	0.24	0.085	0.451
Karachay-Cherkess Rep.	0.582	0.487	0.416	0.32	0.30	0.421
Kabardino-Balkar Rep.	0.368	0.455	0.713	0.23	0.175	0.388
Republic of Dagestan	0.705	0.41	0.43	0.21	0.13	0.377
Krasnodar region	0.417	0.486	0.42	0.31	0.225	0.371
Republic of Kalmykia	0.562	0.505	0.4	0.19	0.145	0.36
Republic of Ingushetia	0.082	0.522	0.19	0.13	0.025	0.189

In terms of the intellectual potential development index the Rostov region is comparable with Moscow which is ranked the first among Russian regions. In terms of academic staff the Rostov region (0.69) falls behind Moscow (0.89). In terms of R&D employment the Rostov region (0.86) falls behind Moscow (1.0), but it exceeds Moscow (0.64 and 0.38 respectively) in terms of research intensity. Thus, the intellectual potential development index of Moscow slightly exceeds that of the Rostov region (0.82 and 0.71 respectively).

Comparison of the intellectual potential development indices of the South Russian regions with per capita Gross Regional Product shows that intellectual potential in general has a positive impact on the Gross Regional Product. Thus, the Rostov, Astrakhan and Volgograd regions, the leaders of intellectual potential development, are ranked high in terms of per capita Gross Regional Product. Therefore, most of the South Russian regions are not characterized by the tendency to develop knowledge-based economy. In such a situation, it is of great importance to identify priorities in human potential development. In order to improve social development controllability we would recommend, first and foremost, regional social policy development based on human and intellectual potential development monitoring; second, government support and incentives differentiated for the regions according to their levels of intellectual potential development.

Now let's analyze how intellectual potential interrelates with sectoral trajectories at the regional level. The current stage of regional innovation development is characterized by the introduction processes which contribute to fast return on investments. Equipment costs in mining and processing industries, energy, gas and water production and distribution amounted to 50% in 2006-2012. Equipment costs in communications, IT technologies, and wholesale are 80% (The indicators of innovation activity 2012).

Statistical data analysis showed that there are obvious disproportions between some types of innovation activity. Training costs in mining and processing industries amounted to 0.2-0.7%, the same situation is typical of telecommunications and IT technologies. Marketing research expenses amounted to 0.1- 0.2% in mining and processing industries, and 0.1-0.05% – in telecommunications and IT technologies (The indicators of innovation activity 2012).

Research and development, the most widespread innovation activity among industrial enterprises, accounts for a small share in the total innovation costs (12.7% and 0.2%) indicating that regional industries focus on practical implementation of innovations, as well as low capital intensity of research activities mostly aimed at applicability of new products for the technical needs of the enterprises. Research intensity indicator expressed as R&D expenditure of shipped goods also proves low scientific potential. Among three groups of industries under study, enterprises with good R&D basis for innovations haven't been found. Research intensity level in electrical equipment production is 0.5%, in metallurgy, despite highly developed sectoral science, – 0.04%, in food production it is minimal – 0.003% (Antonenko, 2010). Thus, the main sources of innovations used at the regional level can be classified into internal sources based on in-house R&D, and external ones that use the services of innovation companies and venture funds-suppliers of equipment and software.

We analyze how technological innovation expenditure in various types of innovation activity correlates with sectoral trajectories. In-service training and equipment suppliers (in agriculture, textile industry) are the main sources of technologies in supplier-dominated sectors. Personnel training for this sectoral trajectory is 0.7%, and marketing research – 0.1%. Despite expenditure reduction in agriculture and textile industry, their growth was more than 100%. Therefore, the main sources of innovations are suppliers of equipment and materials. The firms in these sectors prefer to focus on innovative production modes and raw materials.

Analyzing scale-intensive sectors we should notice that they are characterized by a considerable increase in expenditure on technological innovations. Technological innovation expenditure for the sectoral trajectory also shows growth trend. For example, R&D expenditure rose from 4.8% to 12.7%, machinery and equipment acquisition – from 43.9% to 52.6%, acquisition of new technologies – from 1.7% to 2.5% (The indicators of innovation activity 2012). Therefore, the main sources of technological innovations are R&D departments of the firms, engineering, equipment and components suppliers. The analysis of science intensive production showed that technological innovations arise due to R&D activities at the firm and depend mostly on new discoveries and know-how. For example, in-depth research expenditure in the South Russian regions rose 63% (Russia's regions, 2012). Technological innovation expenditure rose from 23% to 75% in electrical equipment production, optical equipment production, electronics, and telecommunications. The analysis of information-based sectors showed that software purchase fell from 11.8% to 5.2% while IT and computer activity rose 59% in the South Russian regions (Russia's regions, 2012). Therefore, software, IT departments, software and computer suppliers are considered to be the sources of technological innovations.

The analysis of specialized suppliers sectors showed that machinery and equipment production in the South Russian regions rose 308% while expenditure in IT and computer activity rose from 76.4% to 88.6% (The indicators of innovation activity,

2012). Therefore, design and production of specialized elements are considered to be the sources of technology innovations in these sectors.

In terms of technology innovation expenditure structure the South Russian regions cannot be considered innovators as expenditure on machinery and equipment rose considerably (52.6- 88.6% in 2007) while R&D expenditure rose insignificantly (0.2-12.7%) (The indicators of innovation activity 2012), at the same time innovators' R&D expenditure amounted to 80%. We should notice that 'the absolute scale of the expenditure spent by the Russian firms for external R&D cannot be compared to the scale of the Russian R&D sector: demand for R&D made by outside organizations is ten-fold lower than potential supply which means that imported efficient technologies are more preferable' (Strategic guidelines of Russia's economic development, 2010).

We investigate sectoral specifics of innovation strategies of the firms of the of South Russian regions. Scale-intensive sectors of the South Russian regions prefer to purchase news technologies and equipment from foreign firms. Thus, the innovation strategy of these firms mainly focuses on modification and adaptation of imported technologies to the Russian conditions. It is proved by a small share of R&D expenditure in the overall expenses for technological innovation. Russian firms prefer to create their own R&D centers rather than support and develop sectoral R&D. Technology transformations resulted in a situation when sectoral firms formed their own R&D strategy that makes it possible for these firms to carry out innovation programs and implement innovations on a new technological basis. Science-based sectors began to position themselves as strategic innovators implementing their own inventions and promoting their R&D. Science-based sectors is the driver of current knowledge economy's growth. The innovation model of science-based sectors is characterized by wide implementation of cutting-edge foreign technologies, marketing of new products and services. Despite these sectors act mainly as imitators, there is nothing to prevent them from moving on to a new innovation technology level. Though IT sectors develop very rapidly, their share in the Gross Regional Product remains low which means that they need government support. Thus, supplier-dominated and scale-intensive sectors can be characterized as imitators while science-based sectors as innovators. In order to bring together the trajectories of innovation and technology development it is necessary to implement existing technologies into production rather than enhance innovation activity.

As a matter of fact, the firms within sectoral trajectories under investigation do not move on to a new stage of innovation-technology development as they do not open new design centers, purchase research institutes, pursue an active patent-license policy, acquire small innovation companies, establish venture funds to invest science intensive projects, and do R&D, they still remain at the 'market innovation' stage as they develop sales and distribution networks, create vertically integrated holding companies, renew and expand the range of goods. The short-term aim is to move on to a modernization stage characterized by creation of R&D departments at the firms within these sectors.

It should be noted that innovation and technology development trajectories of the South Russian regions tend to converge due to the fact that technologies determine demand for innovations. It is of vital importance to maintain high level of technologization of the region's economy in order to achieve quantitative and qualitative growth of innovations. Therefore, at a modernization stage it is imported technologies but not creation of new ones must be the basis for sectoral trajectories development.

Technology imitation is more effective and beneficial for a certain stage of regional sectoral development of the South Russian regions owing to limited capacity to create and implement innovations on the out-of-date technological base, complementarity of technologies, cheap and riskless imported technologies (Strategic guidelines of Russia's economic development, 2010).

Foreign trade, purchase of companies abroad, transfer to the open innovations system can be the channels of import and distribution of new technologies. Therefore, it is necessary to move from the closed innovation system to the open innovation system. The former is characterized by generation and development of ideas, creation of the product and its promotion within one company. Currently, global competition, venture capital growth and accelerating of some technologies undermine closed innovation system development. The company not being able to implement its innovations suffers R&D losses, just like the company which succeeded in commercialization of its innovation does not invest in further innovations. Open innovations imply the use of both in-house and external ideas, and new ways to launch their own new technologies. For open innovation system it is external R&D and better business model that make it possible to commercialize new technologies. This model is characterized by value characteristics of technology, methods of its distribution and sale, and competitive strategy. Thus, business model acts as a mediator which combines technology and economy in the innovation sphere. In terms of innovation potential development of the South Russian regions the leading group consists of three regions: the Rostov, Volgograd and Krasnodar regions. These regions are the most attractive for public and private investments in innovation potential development (Antonenko, 2009). The gap between the groups is quite big. Thus, to develop innovation sphere of Russia's economy the government should provide support and incentives differentiated for the regions according to their levels of innovation potential development.

According to Table 2 the highest innovativeness among all regions within sectoral trajectory of science-based products is typical of electronics and optical equipment production, as well as chemical production which implies search for new technology markets. Among specialized suppliers sectors, machinery and equipment production takes a leading position in terms of innovation level.

Table 2. Research intensity indices of the South Russian regions, 2008-2012

Sectors of the South Russian regions	Research intensity, %
Processing industries Krasnodar region	0.020
Processing industries Volgograd region	0.005
Processing industries Rostov region	0.140
Food production Krasnodar region	0.009
Food production Volgograd region	0.210
Chemical production Volgograd region	0.080
Chemical production Rostov region	0.100
Machinery and equipment production Krasnodar region	0.070
Machinery and equipment production Volgograd region	0.580
Machinery and equipment production Rostov region	0.006
Electronics and optical equipment production Krasnodar region	0.750
Electronics and optical equipment production Rostov region	1.070

Source: <http://www.gks.ru/dbscripts/Cbsd/DBInet.cgi>

This sectoral trajectory implies design and production of specialized elements, as well as technology development as a key factor for product modifications and improvement. Among scale-intensive sectors, processing industries are ranked the first. This sectoral trajectory implies development of in-house R&D departments, adaptation of foreign technologies to the Russian conditions, and development of their R&D strategy.

4. Conclusions

Most of the South Russian regions are not characterized by the tendency to develop knowledge-based economy. In such a situation, it is of great importance to identify priorities in human potential development. In order to improve social development controllability we would recommend, first and foremost, regional social policy development based on human and intellectual potential development monitoring; second, government support and incentives differentiated for the regions according to their levels of intellectual potential development.

Therefore, the above-mentioned sectors – leaders of the sectoral trajectories – need innovation development programs and sectoral innovation diversification programs. It is also necessary to identify R&D development lines and amount of financing. As for outsiders, both regions and sectors, they need new investment programs aimed at increasing their technological level in order to make them open to technological innovations.

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