The Role of "Triple Helix" Innovative Model in Regional Sustainable Development

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Abstract. Every year, the importance of innovation policy as a part of economy's sustainable development is growing. The state approaches this policy thoroughly enough and carefully searches for ways of the most effective formation of the national innovation infrastructure. In this regard, the "Triple helix" model must be considered as one of the most successful models of innovation development of mining regions' economy. The analysis of the possibilities of its implementation in the mining region (on example of Kemerovo region, Western Siberia, Russia) should be based upon the experience of another mineral resource region – Tomsk oblast. Among the problems hampering the effective functioning of the triple-helix model in the Kemerovo region, the authors describe the reduction in the staff engaged in research and development, intellectual and business migration, low financial activity, lack of support from federal and regional authorities. Only by implementing a system of measures aimed at applying the "Triple helix" model as the basis for regional innovation system, Kemerovo region can change its way for sustainable development.

1 Introduction

At present, the innovative development of many countries is based on the "Triple helix" model. This model was formulated at the beginning of the 21st century by Professor H. Etzkovitz from Stanford University and L. Leydcsdorff, professor of the University of Amsterdam.

The "Triple helix" symbolizes the interaction between the government (authorities), scientific, educational organizations and business, which are the main elements of the national innovation system. This model shows the involvement in the interaction of certain institutions at each stage of innovative products creating. At the stage of knowledge creating, the government and scientific and educational organizations interact with each other. After that, cooperation of science with business is realized through the transfer of technologies. The last stage, i.e. placing the outcomes of innovation activities on the market, is the result of the joint activities of authorities and business. However, the "Triple helix" model is applicable not only at the macro level, but also at the level of the regions.

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2 Material and methods

Issues of sustainable development in general, and innovative development and dissemination of innovations in particular, are widely covered by Russian and foreign researchers, among which are: G. Mensch [1], J. Schumpeter [2], B. Lundvall [3], N. Kondratieff [4], S. Glazyev [5], S. Zhironkin [6], M. Gasanov [7], etc. The problems of regional innovation and technological development were considered in the papers of E. Dotsenko [9] and N. Ezdina [10]. The model of the "Triple helix" is considered by H. Etzkovitz and L. Leydcsdorff [11].

3 Results and discussion

Nevertheless, the two types of models for building an innovative economy have already been implemented in Russian mining regions [12]:

- exogenous models, i.e. introduced from the outside;
- endogenous models, arising from region's innovative potential implementation.

An example of a model of the first type is Yakutia. There, regional authorities were able to create attractive conditions for the influx of representatives of innovation business into the region. One of the basic advantages of the Yakut approach is the consideration of the demand for innovations shown by mineral resource complex.

Tomsk Oblast, which is the leading resource extracting region in Russia's innovative development, is the best example of an endogenous model. It has a strong scientific base and a powerful innovative infrastructure created over the past decades. In 1991 in Tomsk region there was founded the first Russian techno park, on the basis of Tomsk State University of Control Systems and Radioelectronics.

Currently, the Tomsk Oblast is implementing a project on Innovative Territorial Center "INO Tomsk" creating [13]. The Center is a set of urban territories integrated in solving the problems of innovative development and economic growth stimulating. Tomsk techno park has the transport, social, information, communication and other infrastructures. The project of their development involves 12 federal ministries, 5 large companies, development institutions, 6 universities, more than 10 research organizations, several hundred small and medium-sized innovative industrial enterprises. Within the framework of the techno park's Concept, 6 urban areas of Tomsk agglomeration are developing: industrial, innovative, scientific and educational, historical, cultural, medical and sports. Six clusters with specialization in petrochemistry, nuclear technologies, timber industry, pharmaceuticals, medical equipment, IT, renewable resources, and hard-to-recover reserves have been creating the basis for the Concept implementation.

According to forecasts, by 2020, the Innovative Territorial Center should ensure the creation of 160,000 highly skilled workers, while at the time of 2016 114,800 jobs were created. The share of investment in fixed assets should also increase from 20.1% in 2016 to 27% by 2020. At the same time, an increase in the share of domestic expenditure on research and development in the gross regional product is practically not provided: in 2014 – 2.3%, 2016 – 2.08%, 2020 – 2.4%. Significant growth is forecasted for the volume of goods and services produced by residents of the Tomsk techno park's innovation center (in 2016 – 2.7, in 2020 – 9.7% of the gross regional product). It also provides for the growth of private investment, which should increase more than 2 times from 2.2 to 5% of the gross regional product.

However, it is necessary to understand, that regardless of the type of innovation model implemented in the region (endogenous or exogenous), two essential conditions are necessary for its success. First, a certain level of development of regional institutions. Secondly, the partnership of research and education systems, government and business.

This partnership is what is called the "Triple Helix" model. According to the concept of this model, it is necessary to involve all key partners –government, business, research and educational complex, with the opportunity to lead each of them, especially at the initial stage of the process of creating an innovative economy and sustainable development initiation. The concept of the "Triple Spiral" provides for step-by-step innovative development as a result of constructive interaction of the research and educational complex, business and government (at national and regional levels). Initially, there are "Double spirals", i.e. interaction between science and business, business and government, etc., which then form a "Triple helix".

In the conditions of "knowledge economy" formation, the role of research and educational organizations interlinking is growing, which is already the basis and source of sustainable development. Preserving the function of conducting scientific research and development, as well as educational activities, the scientific and educational complex begins to fulfill the entrepreneurial component both in the part of the educational process and in terms of regulations and management procedures [14]. In the knowledge society, such a structure is being formed as a research university, which begins to play an expanded role, targeting the "knowledge capitalization of" as an academic goal. Therefore the role of research universities in the regional "Triple helix" model is to develop the research and technological complex and to provide it with the necessary human resources through research, transfer of technology to the industry and the formation of the "innovative belt" of companies around the university. Thus, the research university becomes an active player in the socio-and-economic development of the regions [15].

Let us consider in details the economic situation in Kemerovo region. In the structure of the gross regional product of Kemerovo region, the main economic activity was the extraction of minerals: in 2005 - 27.1%, in 2010 - 31.4%, in 2015 - 25.6%.

Let's turn to the index of innovative activity of organizations (Table 1). Unlike other regions, rather low value of this indicator is observed in Kemerovo region. In 2005, it was 7.3% (in the Siberian Federal District – 8.1%, in Russia – 9.9%), in 2010 – 5.9% (in Siberian Federal District – 8.2%, in Russian Federation – 9.5%), in 2015 – 3.9% (in Siberian Federal District – 8%, in Russian Federation – 9.3%), in 2016 – 3.2% (in Siberian Federal District – 6.9%, in the Russian Federation – 8.4%). The situation is aggravated by negative dynamics of the index of innovative activity. Comparison with the world leaders in this area is also not in Kemerovo region's favor. In 2016, the value of the innovation activity indicator of organizations was: in Switzerland – 75.3%, in Brazil – 72.6%, in Germany – 67.0%, in Canada –54.8%, in China – 41.3%.

Table 1. The inter-regional distribution of the innovative activity of organizations, % [16].

	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Russian Federation	9.9	9.5	10.4	10.3	10.1	9.9	9.3	8.4
Siberian Federal District	8.1	8.2	8.8	8.5	9.1	8.8	8	6.9
Krasnoyarsk region	8	10	10.2	9.5	11.2	9.3	8.8	7.1
Irkutsk region	9.2	8.7	6.5	6.9	8.7	6.4	7.9	4.8
Kemerovo region	7.3	5.9	6.4	6.1	4.6	7	3.9	3.2
Novosibirsk region	5.3	5.5	8.2	8.6	9.9	9.7	9.4	7.6

Kemerovo region does not belong to Russian Federations innovative leaders and therefore faces a number of problems in the creation, implementation and promotion of innovations. The reasons for this lag, both at the regional and national levels, according to the authors, originate from the following.

First, the number of personnel engaged in research and development is being reduced in Kemerovo region. The low level of wages in regional R&D sector and degrading prestige of the profession does not ensure the inflow of young scientists.

Secondly, the problem of intellectual and business migration, which is directly related to the outflow of specialists in the scientific and research field.

Thirdly, low financial activity, including commercial sector aimed at obtaining new knowledge and their practical implementation.

Fourth, lack of support from the government, not only material, but also moral [17].

All this is confirmed by the data presented in Table. 2. As in Russian Federation as a whole, the number of organizations performing scientific research and development for the period 2005-2016, in the Kemerovo region has changed insignificantly: only in 2015 the indicator grew by 18% (in Russia - by 16%). This can be explained by the activation of research in response to the sanctions policy of Western states, which began in 2014.

Table 2. The number of organizations performing R&D [16].

	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Russian Federation	3566	3492	3682	3566	3605	3604	4175	4032
Siberian Federal District	419	404	424	424	428	424	491	481
Krasnoyarsk region	60	54	53	52	52	52	72	73
Irkutsk region	35	44	46	49	51	45	52	51
Kemerovo region	29	27	27	26	27	27	32	32
Novosibirsk region	119	104	111	113	118	120	122	120

The raw material extracting orientation of Kemerovo region economy has an impact on its innovative developments (Table 3). Other producing regions considerably outstrip it in this direction. In 2015, Kemerovo Region introduced 8 innovative technologies, while the Irkutsk and Novosibirsk regions - more than 20, in 2016 the situation is similar, only Krasnoyarsk region took the leading place. This dynamics is explained by the amount of costs for technological innovation. In 2005, they amounted to 70.2 USD million, in 2012 – 40.3 USD million. In 2013, the decline was almost 2 times – 20.8 USD million. In 2014, the decline was almost to 1 USD million, and then a sharp jump up to 70.5 USDmillion. A sharp increase in the cost of technological innovations in 2012-2013 was the evidence that the economy of Kemerovo region was developing an innovative potential for the next innovation cycle. A "surge" of innovation activity manifested itself in the increase in the volume of innovative goods and servicesproduction. In 2014, there was a "jump" of this indicator in almost 7 times from 56 to 34.2 USD million. In 2015, the volume of innovative products grew by another 30% and amounted to 52.9 USD million.

Table 3. Breaking technologies development [16].

	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Russian Federation	637	864	1138	1323	1429	1409	1398	1534
Siberian Federal District	68	64	126	151	123	116	92	107
Krasnoyarsk region	15	6	33	38	24	26	19	35
Irkutsk region	4	10	7	53	41	31	22	10
Kemerovo region	6	7	14	11	10	3	8	7
Novosibirsk region	21	23	53	31	26	30	23	30

As shown by the analysis, the innovation activity of the Kemerovo region is much lower than in most other regions. Innovative changes take place here more slowly. According to experts, the reason for this lies in the lack of the necessary infrastructure for technological development, including ensuring interaction between science and business.

In Kuzbass, the "double spirals" of innovative development forming has been launched with varying degrees of success:

- “scientific and educational complexes – business. This interaction is still insufficiently developed and can not be regarded as a coherent "spiral" of development.
- “government – the raw materials extracting industry”. The financial power of the raw materials complex makes the opportunity to establish its confidential relations with the government, which directly participates in the industry's revenues as a co-owner of large business.
- “government – the rest of the business”. Most enterprises of other industries in Russia do not yet come out of stagnation, which began in the last decade. Those enterprises that are able to enter the market of innovations to create import-substituting products, mainly consume imported equipment.

One of the instruments for "triple spiral" model implementing is techno park structures. Techno park is a property set in which research institutes, industrial facilities, business centers, exhibition grounds, educational institutions, as well as service facilities are united: transport network, residential settlements, security. The objectives of the techno park are:

- creating conditions favorable for the organizations of small innovative enterprises developing;
- accelerating the commercialization of research and development results, inventions and discoveries;
- creation of competitive, export-oriented and import-substituting technologies, goods and services.

They are preparing both new technologies and personnel for corporations, and can also be used to develop specific industries and combat "stuff hunger". Among the mechanisms that are used for this, there are grants, tax breaks, consulting services, inexpensive rental of premises, etc.

The model of the triple helix is revealed in techno park structures as follows. The state creates infrastructure and conditions for their functioning. Research institutes and universities, as a rule, constitute the "core" of the techno park, being the main generator of knowledge. Business, in turn, receives tangible support from the state and scientific organizations, develops and introduces innovative products to the market.

The Kuzbass technopark is the main element of the innovation infrastructure of Kemerovo region. It was established in 2007 on the initiative of the Kemerovo Region Administration. It is a part of 12 techno parks supported by the Ministry of Communications of Russian Federation. The infrastructure of the techno park includes an engineering center, a production and laboratory building "Ecology and Nature Management", a business incubator, a co-working center, and a center for youth innovative creativity. Its functions include the following:

- research of raw and commodity markets, search for information about new technologies;
- provision of infrastructure for business location;
- assistance in the promotion of projects and technologies to target markets;
- assistance in reducing administrative barriers, mediation in cooperation with state and supervisory bodies;
- assistance in attracting financing to projects at different stages of their implementation;
- assistance in the introduction of new management technologies that increase the efficiency of project implementation.

The main areas of the techno park specialization are: coal mining and processing; power engineering, machine building, processing of ore and nonmetallic minerals, ecology, medicine, biotechnology, security, information technology, education.

Kuzbass techno park promotes the transfer of the key industries enterprises to a new technological level, increasing the efficiency of environment protection measures and minimizing the technogenic impact of mining to the nature. For the period 2010-2016 the Kuzbass techno park supported 60 resident companies implementing innovative projects, of which 21 residents were located on its territory. During this period, more than 356 requests for support were considered, 173 innovative projects passed the expert council, 53 projects received regional tax incentives. The number of residents in 2016 was 28, including 26 small and medium-sized enterprises. At the same time, engagement of Kuzbass techno park premises was only 34%.

The total investments of resident companies for 2010-2016 amounted to 50 USD million, the volume of investments in fixed assets – 14.8 USD million, and 1,705 new jobs were created. The aggregate volume of the received income of residents for the period 2010-2016 amounted to 300 USD million, the amount of taxes of resident companies – 18.5 USD million. At the same time, in 2016, the residents' income amounted to 3.2 USD million, the volume of taxes – 0.1, 106 jobs were created. The volume of investments from the budget accumulated totaled 15.2 USD million, including 7.2 USD million from the federal budget and 8 USD million from the regional budget.

Thus, it is obvious that the potential of techno park structures as a tool for implementing the "triple helix" model is colossal, but fully unrealized. Therefore, it is necessary to improve the efficiency of techno parks functioning through effective interaction of all parties involved in the process of innovative development.

4 Conclusions

On the basis of the analysis made in this article, it can be concluded that both at the federal and at the regional levels, in particular in the Kemerovo region, the "triple helix" model can not function effectively due to the imbalance of the national (regional) innovation system, the main elements of which are: the government (regional authorities), business, educational and research institutions. At the moment, in Russia such of these elements acts separately, practically not interacting with each other. The interaction of business, research and educational institutions should be carried out horizontally, without the intervention of the authorities. In the process of joint activity, these elements must substitute each other's functions, for example, business – to pay more attention to education and research. At the same time, education must master the methods and processes of entrepreneurship.

The government and regional authorities must remove the various bureaucratic barriers and procedures that impede or inhibit these processes. In addition, it is possible to stimulate innovative development processes by such instruments as a preferential taxation system for innovative enterprises; allocation of funds from budgets of various levels; provision of subsided loans; organization and promotion of venture funds development. It should be noted that government support does not need to be directed to business and only have a direct financial impact. It is necessary to strengthen the state's attention to fundamental science, inserting it in the list of priority directions of the sustainable development; increase of financial and resource support of science and education, etc.

Practice shows that the high dynamics of sustainable development can not be ensured by the efforts of any one party. Efficiency is possible only with the interaction of all participants in the innovation process. Only with the implementation of a set of balanced measures, the "triple helix" model will bring tangible environmental effect.

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