Tools for Assessment of Innovation Potential of the Business Environment Development in the Region

Denis Victorovich Parshukov, Dmitry Vasilevich Khodos, Natalia Ivanovna Pyzhikova, Kovalenko Elizaveta Ivanovna and Vlasova Elena Yuryevna

Krasnoyarsk State Agrarian University.

DOI: http://dx.doi.org/10.13005/bbra/1982

(Received: 25 July 2015; accepted: 19 September 2015)

The purpose of this study is to assess the innovation potential of the economy and prospects for the innovative development of business environment in a particular economic region. Assessment of the innovation potential was performed using fuzzy set analysis and hierarchy analysis. Innovation level of the business environment and its development priorities were determined by the means of complex numbers. During the study, the authors disclosed the contents of the innovation potential of the regional economy, the allocated groups of the business environment, represented the situational modeling of the dynamics of the development of the innovative activity in the territory (development options and their economic interpretation). In the context of the West Siberian and East Siberian economic regions of Russia, the development of innovation potential of the business environment in the territories was assessed under the author's system of indicators that reveal the content of components of the business activity potential. Modeling the innovation potential of the region and business environment demonstrates the viability and validity of their application for the analysis of real economic processes. The presented authoring tools to study the extent of development of innovative economy of the regions will help shape the effective areas of state regulation and support of the business environment at the macro and micro level. Prospects for research in this area are to build multivariate models using computer calculations.

Key words: Business environment, innovation potential, complex number, fuzzy modeling, innovative economy, innovative activity.

Strategic priorities of any territory are the security of the national economy, availability of the goods and services of high quality at the necessary extent, growth of welfare of the population, development of market infrastructure. The economic development of the territory is based on the interaction of two institutional forms: state and private business. The economic theory has different interpretations of the degree of separation of the economy between state and business, their participation in the distribution of resources, in the ownership structure. However, one can't deny the fact that business in the modern world is becoming the engine of economic growth, an indicator of contemporary forms of transformation of the market economy.

In the Russian practice, it is customary to distinguish four groups of entrepreneurs: big business, medium and small businesses and individual entrepreneurs. These entities represent the entrepreneurial sector of the economy – business environment. The contribution of each of these groups to the Russian economy varies.

According to Rosstat, the contribution of small and medium businesses in Russia's GDP in 2014 was 21%. In 2014, Vnesheconombank's experts conducted a survey of 1,214 managers of this type of business in 16 regions of the country to identify the dynamics of the financial sustainability of the activities and attitudes of

* To whom all correspondence should be addressed.

entrepreneurs. When asked about the challenges of doing business, 47% of the respondents mentioned the tax burden, 44% – the high level of competition, 26% – the unavailability of financial resources. The highest acceptable rate on loans that allows to speak about competitiveness was marked at the level of 13%. At the same time, over the first half of 2015, the weighted average interest rate on short-term loans amounted to 19%, for loans up to 3-year term – 16% (Vnesheconombank, 2014). 2014 was a difficult year to do business. According to analysts, the difficult situation was in lending to small and medium-sized businesses. The negative dynamics deteriorated over the entire 2014 and the first half of 2015, which can be seen from the data in Figure 1.

Many domestic and foreign researchers consider small and medium business the chief

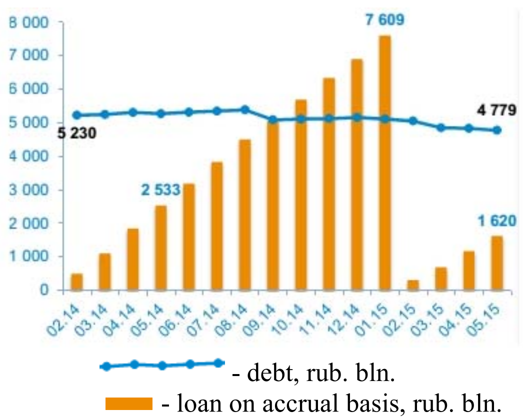

Fig. 1. Dynamics of debt and lending, rub. bln. (VEB. SME Bank, 2015)

conductor of innovations. Lacking the benefits in comparison with large companies and corporations by the scale of production, the size of the customer base, resources and financial capital, a key source of their competitiveness is innovative activity and venture investments. This activity area is risky enough, so if the government is committed to the development of small and medium businesses, it must create the conditions to reduce the risks by providing information, legal and organizational support of innovative activity of the enterprises.

State stimulation of innovation is officially recognized as a key factor in long-term growth of the national economy (OECD, 2010). An important role in the innovative development of the economy is assigned to individual regions. There are studies that empirically confirm a pattern of asymmetric and unequal development of innovative activity in different regions of the state (OECD, 2011, P. 19; Foddi, Usai, 2013). In our opinion, it can be explained by the difference in the value of the innovation potential of the territories and the business environment. In terms of the region, the innovation potential should be considered from three perspectives: the possibility of creating innovations, possibility to carry out effective innovative activity, possibility of implementation of innovations by enterprises, as shown in Figure 2.

Hence, the innovation potential of the region (territory) is a set of possibilities of creation and development of effective innovation implementation in the territorial entity.

The business potential of the region is the possibility of increasing the competitiveness

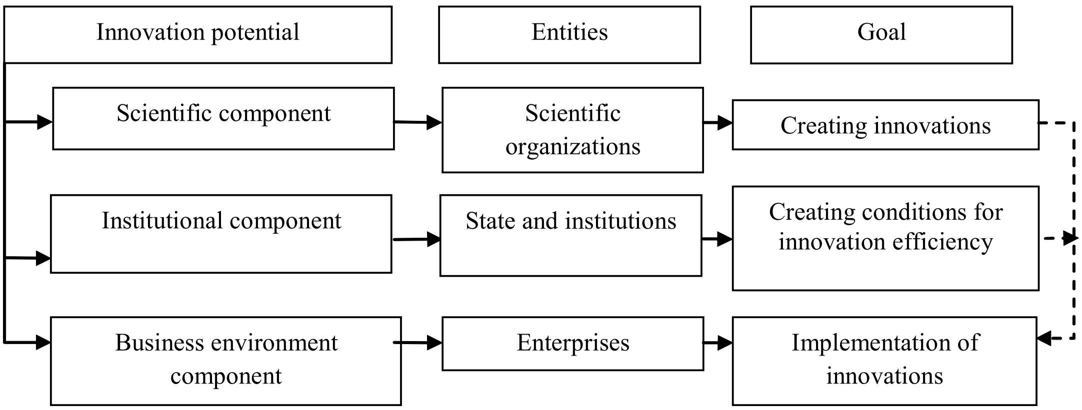

Fig. 2. Essence of the innovation potential of the region's economy

of its own commercial product by implementing innovative technologies in a particular region. In this case, the most important indicators for assessment are the ones that characterize financial, managerial and organizational capacities of enterprises.

The scientific potential of the region is the ability of the regional research organizations to create innovations that have practical application in the industrial and economic activity. In this case, the most important indicators for assessment are the ones that characterize intellectual and material resources of organizations.

These assumptions make it possible to analyze the perspectives of innovative development of the regions by the extent of

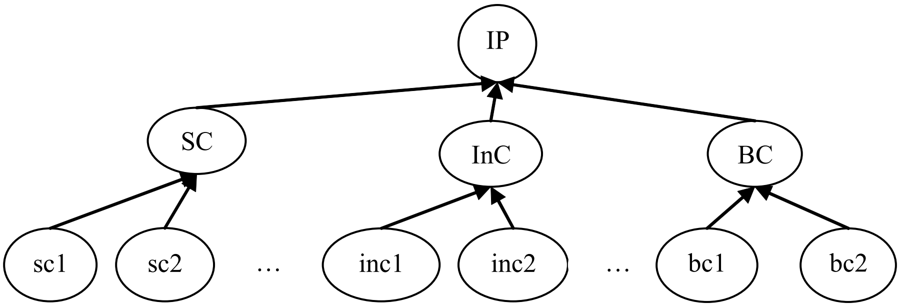

Fig. 3. Tree hierarchy of the innovation potential

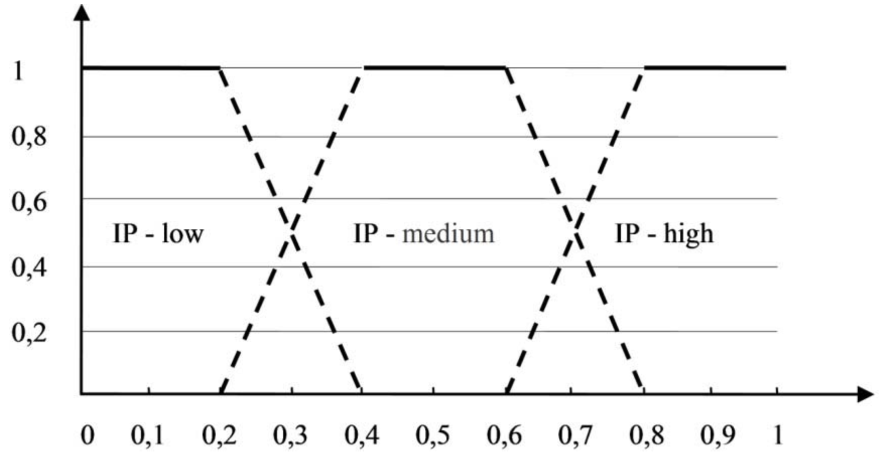

Fig. 4. Scale of possible values for the innovation potential

Table 1. IP, C level classification based on SFC

Interval of IP value	IP, C level classification	Degree of estimated confidence in belonging to the interval, value *100%, μ
Three-level standard 01-classifier		
0,1≤IP, C≤0,2	Low	1
0,2≤IP, C≤0,4	Low	μ_1=5×(0,4-IP, C)
	Medium	1-μ_1=μ_2
0,4< IP, C<0,6	Medium	1
0,6≤IP, C≤0,8	Medium	μ_2=5×(0,8-IP, C)
	High	1-μ_2=μ_3
0,8<IP, C≤0,9	High	1

innovation potential. Methodological framework is important for conducting such an analysis. Foreign studies most often use methods of multivariate statistical analysis: factor analysis, cluster analysis, principal component analysis (ESPON, 2006; Fraunhofer ISI/MERIT, 2005; Navarro, et al., 2008; Marsan, Maguire, 2011; Capello, Lenzi, 2012). Domestic works, along with statistical methods, use the ratings by individual indicators and the calculation of the common criteria based on them (Hochberg et al., 2012; Kiselev V.N., 2010; NAIRIT, 2011; IISP, 2008). The authors of this study suggest their own approach.

METHODOLOGY

Fuzzy set assessment of innovation potential

Innovation potential is suggested to consider as aggregate IP indicator, the value of which will depend on the numerical values of its

Table 2. Situational modeling of the dynamics of development of innovative economy in the region

Possible developments	Dynamics of the real and imaginary parts of the numbers	Possible options of R_Z and [phi] dynamics	Economic interpretation
Situation Z1	X grows, Y declines	R_Z grows, [phi] grows	Investment growth Increased costs of technological innovation and the volume of innovative products and services contribute to the expansion of the scale of the innovative economy. The scale and profitability of cost are determined by the increase in the technology investment.
Situation Z2		R_Z grows, [phi] declines	Production growth Increased costs of technological innovation and the volume of innovative products and services contribute to the expansion of the scale of the innovative economy. Production volumes are growing at a faster pace.
Situation Z3	X grows, Y declines	R_Z grows, [phi] declines	Production growth Growth rates of production of innovative products and services exceed the rate of decline in the costs of technological innovation. The scale of the economy and profitability increases due to the efficient development of innovations in production.
Situation Z4		R_Z declines, [phi] grows	Risk of underfunding of innovative business projects The pace of reducing the costs of technological innovation exceeds the rate of growth in production of innovative products and services. Decline in the scale of the innovative economy is due to lack of investment, while the profitability of cost remains high enough.
Situation Z5	X declines, Y grows	R_Z grows, [phi] grows	Investment growth, production risk The growth rate of the costs exceeds the rate of decline in the production of innovative products and services. The scale of the innovative economy grows due to technology investments, there is an increase in profitability of cost of the technological innovation. There is an increase in the investment lag.
Situation Z6		R_Z declines, [phi] declines	Pre-crisis situation The pace of decline in the production of innovative products and services exceeds the growth rate of costs of technological innovation. Decline in the scale of the innovative economy is due to the lack of production capacity.
Situation Z7	X declines, Y declines	R_Z declines, [phi] grows	Recession in the innovative economy The rate of decline in production volumes is below the rate of decline in the cost of technological innovation. Decline in the scale of the innovative economy is primarily due to the reduction of technological investment, but high profitability of cost constrains the decline.
Situation Z8		R_Z declines, [phi] declines	Adverse spiral The pace of decline in the cost of technological innovation exceeds the rate of decline in the production of innovative products and services. Lack of investment and decline on profitability of cost increases the investment and operational risks, which consistently causes the decline in investments.

individual components: SC – scientific component, InC – institutional component, BC – business environment component. Since each component must be described by a set of indicators, the assessment of the innovation potential can be obtained in the analysis of the hierarchy in Figure 3.

Mathematical economic logical model of the innovation potential is written as (Parshukov, 2011):

$$IP = G\{C(SC,\ InC,\ BC),\ L\} \qquad ...(1)$$

where C – a set of components; L – a term set of possible qualitative assessments of the level of any of the elements included in the model: L = {Low level (L), Medium level (M), High level (H)}; G – a symbol of hierarchy.

In order to estimate the IP indicator, we need to combine the data collected under the tree hierarchy; the direction of the assessment will match the direction of hierarchy arcs (from the lower-level elements to the root element).

The scale of numeric IP assessments will be given on the interval (0;1) in the form of a standard three-level fuzzy classifier (SFC) in Figure 4. The classifier is built by analogies described in the works on fuzzy modeling (Nedosekin, 2003).

The author's approach to the assessment of the innovation potential involves drawing associations between quantitative estimates of IP model elements and their qualitative economic characteristics.

The numerical values of the elements of the first level of the hierarchy – component C (SC, InC, BC) – are determined by the formula of double matrix product (Parshukov, 2011):

$$\hat{C} = P_c \times K_c \times V = (p_1 \ \ \dots \ \ p_m) \times \begin{pmatrix} k_{11} & k_{12} & k_{13} \\ \dots & \dots & \dots \\ k_{m1} & k_{m2} & k_{m3} \end{pmatrix} \times \begin{pmatrix} 0{,}1 \\ 0{,}5 \\ 0{,}9 \end{pmatrix} = 0{,}1 \times \sum_{i=1}^{m} \sum_{j=1} p_j k_{i1} + 0{,}5 \times \sum_{i=1}^{m} \sum_{j=1} p_j k_{i2} + 0{,}9 \times \sum_{i=1}^{m} \sum_{j=1} p_j k_{i3}. \qquad ...(2)$$

Table 3. Situational modeling of the dynamics of innovation in the region

Possible developments	Dynamics of the real and imaginary parts of the numbers	Possible options of R_G and [gamma] dynamics	Economic interpretation
Situation G1	M grows, N grows	R_G grows, [gamma] grows	Development of innovative activity Dynamics of growth of domestic spending on research and growth in the number of employees engaged in research help to increase the scale of innovation.
Situation G2		R_G grows, [gamma] declines	Development of scientific creativity Innovative activity is developed through the expansion of scientific and creative potential of employees.
Situation G3	M grows, N declines	R_G grows, [gamma] declines	Development of innovative activity, risks of decline in the scientific activity Development of innovative activity is due to sufficient funding, but the decline in the number of employees involved in research may affect the scientific creativity in the future.
Situation G4		R_G declines, [gamma] grows	Narrowing innovative activity, risks of decline in the scientific activity Decline in the scale of the innovative economy is due to the reduction of scientific personnel, and its financial support is growing not rapidly enough.
Situation G5	M declines, N grows	R_G grows, [gamma] declines	Risk of underfunding of innovation. The scale of innovation grows due to increase in scientific and creative potential, while financial support for scientific work declines.
Situation G6		R_G declines, [gamma] grows	Narrowing innovative activity, risk of underfunding Decline in the scale of innovative activity is due to lack of its financing and the reduction in research.
Situation G7	M declines, N declines	R declines, [gamma] grows	Recession in innovative activity Decline in the scale of innovation is due to a reduction of investment financing, but the current level of financial support of the scientific work constrains the depth of the recession.
Situation G8		R_G declines, [gamma] declines	Adverse spiral Lack of funding and reduced financial support for scientific work reached a level that causes a reduction in staffing of innovative activity, which further causes a reduction in funding.

In the formula (2), $\hat{C}$ – estimated component, row matrix $P_{\tilde{N}}=(p_1, \dots, p_m)$ – weights between indicators of the estimated component that we suggest to calculate using the Saati method of matching the weighting factors (Saati, 2008).

K_C matrix is a classification matrix. Each row of the matrix corresponds to one of the indicators to assess the component. If the value of this indicator is recognized by the investigator as high, the row is written as (0 0 1), if as medium, i.e. satisfactory, then (0 1 0), and if as low – (1 0 0). The matrix will contain two kinds of numbers 0 and 1, and the sum of the elements in a row is 1. V are the peaks of the SFC classification intervals.

According to the authors, the importance or the contribution of each component to the level of innovation potential is equal. Therefore, the innovation potential is calculated as follows:

$$IP = \frac{1}{3}(S\hat{C} + In\hat{C} + B\hat{C}) \quad \text{...(3)}$$

If the values of the components are different, the weights are determined by Saati method. IP recognition will be made according to Table 1.

The advantage of the proposed tools is the ability to use the agreed indicators measured in different and disparate values (absolute and relative). There is a possibility of quantitative and qualitative interpretation of the values of IP and its components.

Modeling the prospects of development of innovative business environment

Since the ultimate goal of the study is to assess the prospects of innovative development of the business environment, the next stage of the analysis necessary is to determine the necessary tools. The authors chose the means of complex numbers. The study was based on the studies and works of leading Russian economists in this area Svetunkov S.G., Svetunkov M.S., Svetunkov I.G. Selection of these methods is due to the broad

Table 4. Composition and performance assessment of the innovative capacity of the business environment in the region

Root element	Components	Characteristic indicators
Innovation potential of the region	Scientific component	sc1 - cost of purchase of equipment for scientific research per one organization engaged in R&D, rub. thous.
		sc2 - number of patents granted to the number of employees engaged in scientific research, ea.
		sc3 - number of thesis defenses to total number of graduates and doctoral students, ea./pers.
		sc4 - number of graduates and doctoral students per a scientific organization, persons
		sc5 - number of employees engaged in research and development to economically active population, %
		sc6 - number of university students per 10,000 people, pers.
	Institutional component	inc1 - Innovative activity of organizations, %
		inc2 - volume (by value) of shipped innovative products and services to the total cost of shipped products and services, %
		inc3 - return on investment in fixed assets, %
		inc4 - quality of institutions
		inc5 - capital-labor ratio of the region as the ratio of fixed assets to the number of population employed in the economy, rub. mln.
	Business environment component	bc1 - number of advanced technologies used per 1 enterprise, ea.
		bc2 - profitability of technological innovation, %
		bc3 - return on investment in physical assets, %
		bc4 - depreciation of fixed assets, %

Note: The indicator "Quality of institutions" and its value was taken from the work (Agency for Strategic Alternatives, 2015).

economic modeling capabilities and production processes, as well as the ability to describe the non-linear changes in economic indicators. Using the methodological principles outlined in the works (Svetunkov, 2012; Svetunkov, 2011), we obtained the following models and relationships.

Let's introduce a complex number Z – the results of the innovation sector of the economy where the real part X is the volume of innovative products and services, and the imaginary part Y is represented by the cost of technological innovation:

$$Z = X + Yi$$

Characteristics of the complex number are the radius vector R and the polar angle [phi].

$R_Z = \sqrt{X^2 + Y^2}$ – scale of the innovation sector of the economy;

$\varphi = \mathrm{arctg}\,\frac{Y}{X}$ – profitability of cost.

The exponential notation of the complex number makes complex arithmetic operations between complex numbers impossible: exponentiation, root calculation, calculation of the logarithms. Trigonometric notation allows to describe non-linear and cyclical trends of changing the real and imaginary parts. Notations of Z are the following:

$$Z = R_Z e^{i\varphi} = R_Z \sin\varphi + iR_Z \cos\varphi$$

Let's introduce a complex number G – resources of innovative activity, where the real part M is the internal costs of innovative activity and the imaginary part N is the number of employees engaged in research and development:

$$G = M + Ni$$

Table 5. Weights for the indicators of the scientific component

	sc1	sc2	sc3	sc4	sc5	sc6	Total by lines	Weight
sc1	1.00	2.00	2.00	4.00	4.00	5.00	18.00	0.30
sc2	0.50	1.00	2.00	3.00	4.00	5.00	15.50	0.26
sc3	0.50	0.50	1.00	3.00	2.00	4.00	11.00	0.18
sc4	0.25	0.33	0.33	1.00	2.00	4.00	7.92	0.13
sc5	0.25	0.25	0.50	0.50	1.00	3.00	5.50	0.09
sc6	0.20	0.20	0.25	0.25	0.33	1.00	2.23	0.04
						Total by row	60.15	1

Table 6. Weights for the indicators of the institutional component

	inc1	inc2	inc3	inc4	inc5	Total by lines	Weight
inc1	1	2	3	4	7	17	0.38
inc2	0.5	1	2	3	5	11.5	0.26
inc3	0.33	0.5	1	2	4	7.83	0.18
inc4	0.25	0.33	0.5	1	4	6.08	0.14
inc5	0.14	0.2	0.3	0.25	1	1.84	0.04
					Total by row	44.3	1

Table 7. Weights for the indicators of the business environment component

	bc1	bc2	bc3	bc4	Total by lines	Weight
bc1	1	1	2	2	6	0.33
bc2	1	1	1	2	5	0.28
bc3	0.5	1	1	2	4.5	0.25
bc4	0.5	0.5	0.5	1	2.5	0.14
				Total by row	18	1

We will determine the radius vector of the complex number $R_G = \sqrt{M^2 + N^2}$ as the scale of innovative activity, and the polar angle $\gamma = \mathrm{arctg}\,\frac{N}{M}$ is the financial support for scientific work.

The exponential and trigonometric notations of a complex number:

Table 8. Evaluation of the level of development of innovation potential of the business environment of economic regions

Region	Indicator	2010	2011	2012	2013
	East Siberian economic region				
Republic of Buryatia	Innovation potential	0.507	0.460	0.484	0.495
	Scientific component	0.536	0.412	0.484	0.708
	Institutional component	0.548	0.756	0.756	0.452
	Business component	0.436	0.212	0.212	0.324
Republic of Tyva	Innovation potential	0.357	0.423	0.387	0.387
	Scientific component	0.312	0.588	0.552	0.552
	Institutional component	0.548	0.244	0.172	0.172
	Business component	0.212	0.436	0.436	0.436
Republic of Khakassia	Innovation potential	0.289	0.283	0.359	0.425
	Scientific component	0.132	0.184	0.204	0.236
	Institutional component	0.3	0.228	0.436	0.604
	Business component	0.436	0.436	0.436	0.436
Altai Region	Innovation potential	0.523	0.549	0.521	0.596
	Scientific component	0.468	0.468	0.484	0.484
	Institutional component	0.564	0.868	0.868	0.868
	Business component	0.536	0.312	0.212	0.436
Transbaikal Region	Innovation potential	0.407	0.493	0.452	0.476
	Scientific component	0.484	0.516	0.484	0.484
	Institutional component	0.3	0.508	0.436	0.508
	Business component	0.436	0.456	0.436	0.436
Krasnoyarsk Region	Innovation potential	0.388	0.421	0.484	0.581
	Scientific component	0.556	0.656	0.556	0.848
	Institutional component	0.396	0.396	0.684	0.684
	Business component	0.212	0.212	0.212	0.212
Irkutsk Region	Innovation potential	0.388	0.417	0.447	0.555
	Scientific component	0.608	0.796	0.676	0.848
	Institutional component	0.244	0.244	0.452	0.604
	Business component	0.312	0.212	0.212	0.212
Kemerovo Region	Innovation potential	0.425	0.443	0.303	0.488
	Scientific component	0.484	0.536	0.484	0.536
	Institutional component	0.356	0.356	0.212	0.492
	Business component	0.436	0.436	0.212	0.436
	West Siberian economic region				
Novosibirsk Region	Innovation potential	0.374	0.321	0.455	0.583
	Scientific component	0.26	0.188	0.436	0.556
	Institutional component	0.452	0.452	0.604	0.756
	Business component	0.411	0.324	0.324	0.436
Omsk Region	Innovation potential	0.451	0.417	0.457	0.555
	Scientific component	0.556	0.588	0.556	0.848
	Institutional component	0.452	0.452	0.604	0.604
	Business component	0.344	0.212	0.212	0.212
Tomsk Region	Innovation potential	0.663	0.619	0.601	0.676
	Scientific component	0.796	0.848	0.796	0.848
	Institutional component	0.868	0.796	0.796	0.868
	Business component	0.324	0.212	0.212	0.312
Tyumen	Innovation potential	0.519	0.519	0.519	0.519
	Scientific component	0.5	0.5	0.5	0.5
	Institutional component	0.556	0.556	0.556	0.556
	Business component	0.5	0.5	0.5	0.5
Altai Republic	Innovation potential	0.319	0.420	0.316	0.343
	Scientific component	0.38	0.38	0.276	0.132
	Institutional component	0.364	0.668	0.46	0.46
	Business component	0.212	0.212	0.212	0.436

$$G = R_G e^{i\gamma} = R_G \sin\gamma + iR_G \cos\gamma .$$

Relationship between the results of an innovative economy and the results of innovative activity will be represented in the form of the complex function:

$$Z = f(G)$$

$$X + Yi = f(M + Ni)$$

$$R_Z e^{i\varphi} = \alpha R_G e^{i\beta\gamma}$$

The parameters [alpha] and [beta] in different processes may be either real or complex

Table 9 . Characteristics of complex numbers Z, G for Krasnoyarsk and Novosibirsk regions

Region	Characteristics of complex numbers	2010	2011	2012	2013
Krasnoyarsk Region	Innovation sector of the region's economy, Z				
	Real part X, rub. mln.	4957.2	11694.6	35800.1	53874.8
	Imaginary part Y, rub. mln.	14617.7	19643.9	24979.5	67700.4
	Scale of the innovation sector of the economy, R_Z	15435.38	22861.46	43653.44	86520.7
	Profitability of cost, [phi]	1.244	1.034	0.61	0.9
	Resources of innovative activity, G				
	Real part, M (chain indices)	1.243	1.323	1.184	0.913
	Imaginary part, N (chain indices)	1.028	1.042	0.942	1.145
	Scale of the innovative activity, R_G	1.613	1.685	1.513	1.464
	Financial support for scientific work, [gamma]	0.691	0.667	0.672	0.898
Novosibirsk Region	Innovation sector of the region's economy, Z				
	Real part X, rub. mln.	14106.1	16069	24042.4	33832.3
	Imaginary part Y, rub. mln.	3866	5563.1	5745.8	6376
	Scale of the innovation sector of the economy, R_Z	14626.28	17004.73	24719.45	34427.9
	Profitability of cost, [phi]	0.268	0.333	0.235	0.186
	Resources of innovative activity, G				
	Real part, M (chain indices)	1.016	1.188	1.099	1.021
	Imaginary part, N (chain indices)	0.9996	0.998	1.001	0.993
	Scale of the innovative activity, R_G	1.425	1.552	1.487	1.424
	Financial support for scientific work, [gamma]	0.777	0.698	0.738	0.772

Table 10. Situational analysis of innovative development of the business environment of regions

Region	Period 2011-2010	2012-2011	2013-2011	Conclusions
Krasnoyarsk Region	Z2	Z2	Z1	Gradual increase in production of innovative products and services has attracted additional investments in technological innovation, which contributed to the expansion of the innovation sector of the economy through investment growth.
	G2	G2	G5	Change of financial flows in favor of technological innovations has reduced the pace of innovation financing, and in the near future it will be implemented at the expense of accumulated scientific creativity.
Novosibirsk Region	Z1	Z1	Z2	Investment opportunities in innovative sector of the economy in the region reached the limit values, taking into account the development of innovative business environment. Further expansion of this sector will continue at the expense of production possibilities.
	G3	G6	G7	There is a trend of deterioration in the resource support of innovation, which led to recession and growth of project risks. These trends also partly explain the dynamics of characteristics of the complex number Z.

numbers. The parameters for each individual case can be assessed according to available statistics of monitoring with an alternative method of least squares of complex econometrics. A detailed description can be found in the work (Svetunkov, 2012).

Since the real and imaginary parts of the complex number Z are measured in monetary terms, there is no need to adjust them to comparable form. The real and imaginary parts of a complex number G are measured in different terms – rubles and number of people, so they should be adjusted to the dimensionless indicators. To do so, we can use the chain or the basic indices. This assumption does not distort the economic logic of the simulation in defining the functional relationship between the complex numbers Z and G. Since the indices describe the dynamics, the functional dependence will show how the change in volume of resources G determines the result of an innovative economy Z.

Let's model and present the economic interpretation of different options of the dynamics of the real and imaginary parts of the complex numbers Z and G, as well as their characteristics, in Table 2.

As you can see from the above table, the use of complex numbers provides ample opportunity not only to describe the current situation, but also to forecast the trends and prospects of development of innovative economy. Table 3 shows a similar interpretation for the complex number G

Addition of the calculations using the proposed toolkit to assessment of innovation potential will allow to describe the innovative processes of the development of business environment in the region's economy in more detail.

RESULTS AND DISCUSSION

Testing of the proposed toolkit was carried out according to statistics data obtained from Rosstat. The West Siberian economic region and the East Siberian economic region were chosen as pilot sites. Brief description of the regions is presented below.

The main branches of specialization of the WSER business environment: oil and gas production, chemical and forest industry, metallurgy, agriculture, grain and animal husbandry.

The main branches of specialization of the ESER business environment: electricity, fuel, ferrous metallurgy, non-ferrous metallurgy, chemical and petrochemical industry, machine building and metalworking, timber, woodworking, pulp and paper, light and food industries, production of building materials.

Indicators from Table 4 were chosen to assess the components and the value of innovation potential of the development of business environment of the regions – members of the economic regions.

To determine the level of each indicator (except the indicator "Quality of institutions"), its estimated value was compared with the average for Russia without taking into account the data by regions – members of WSER and ESER. If the calculated value falls within the range (value for Russia minus 5%; value for Russia plus 5%), it is interpreted as an average or sufficient. If the regional value of the indicator goes beyond the range to the left (excluding depreciation of the funds), it is interpreted as low. If the regional value of the indicator goes beyond the boundaries of the interval to the right (excluding depreciation of the funds), it is interpreted as high.

Evaluation of weights according to the Saati method is presented in Tables 5-7.

Analysis of the results shows that in most regions the business environment component has a greater impact on the change in innovation potential. The general conclusion on the results of the assessment is as follows.

Regional indicators of innovation potential and its individual component in the WSER and ESER regions compared with values for Russia are average or below average. There are no advanced regions able in the short term to act as growth drivers of innovative economy of the country in the considered economic regions. This is partly determined by industry specialization of regional economies, in which a key role is played by natural resources and raw materials. The condition for the transition to the innovative type of development is to create conditions for deep processing and diversification of industrial production. The current trend is characterized by the fact that big business and regional authorities focus on receiving natural rent, while financial and institutional conditions in the region do not allow small and medium businesses to develop innovative technologies. Inefficient ownership structure of property and weak institutions, lack of the necessary volume of the state orders make the prospects of development of regional business environment on the basis of innovation unfavorable.

Two regions were chosen to test the modeling tools using complex numbers – Krasnoyarsk and Novosibirsk regions. Calculation of the complex numbers Z and G for the chosen regions is presented in Table 9.

Complex numbers informatively describe the current dynamics and trends in the innovation sector of the business environment and research activities in the regions. Let's analyze the obtained values using the situational models from Table 2 and Table 3. The results and conclusions are presented in Table 10.

The use of the proposed modeling tools of innovation potential of the region and business environment brought informative results. This proves the validity and prospects of their application for the analysis of real economic processes.

CONCLUSION

The indicators chosen by the authors for analysis are not the only definition. At the analytical study of the business environment and innovation potential of other countries and regions of the world, one must take into account the institutional and macroeconomic specificity of the territory.

Characteristic features for the Russian economy are the presence of a strong natural resource base, vast territories, diversity of informal, social and cultural institutions. The contractual relationship between government and business are implicit. Rent-focused behavior of economic agents and the government officials' propensity to opportunism are a real problem for the development of the Russian business environment on the basis of innovation. Government initiatives are indirectly aimed at raising taxes from population and abolition of the social obligations of the state, which ultimately affects the effective demand. Under these conditions, small and medium businesses are focused not on the expansion of innovative activities, but on reducing losses. In terms of game theory, it is a maximin strategy. Given that innovation involves high risks, more and more businessmen refuse to implement it.

The research has shown that the methods of modern mathematical modeling allow not only to describe the theoretical economic models, but also to determine the actual conditions of their implementation. The use of complex numbers is justified by the possible economic interpretation of the results and their use in describing the nonlinear dynamics of cyclical fluctuations. Further research in this area will focus on the construction of the functions of complex variables, revealing a statistical relationship between the change in the value of the innovation potential of individual components and complex variables. This is a complex, time-consuming, but realistic process. Prospects for research in this area is to build multivariate models using computer calculations. Furthermore, fuzzy modeling can be used in combination with nonparametric econometrics tools. Sharing these approaches in the assessment of innovation potential and the development of the business environment will be the focus of our future research.

REFERENCES

1. Camagni, R., & Capello, R. (2013). Regional Innovation Patterns and the EU Regional Policy Reform: Towards Smart Innovation Policies. Growth and Change, Vol. 44, 2, 355–389.
2. Economic regions of Russia (2015, Jule 17). In Wikipedia, the free encyclopedia. Retrieved 30.09.2009 from https://en.wikipedia.org/wiki/Economic_regions_of_Russia
3. ESPON (2006) Territorial Impact of EU Research & Development Policy.ESPON Project 2.1.2.Final Report. Retrieved 15.07.2015 from http://www.espon.eu/export/sites/default/Documents/Projects/ESPON2006Projects/PolicyImpact Projects/RDPolicyImpact/fr-2.1.1_final.pdf.
4. Fraunhofer ISI / MERIT (2005) Enlarging the

ERA: Identifying priorities for regional policy focusing on research and technological development in the New Member States and Candidate Countries. Final report. Retrieved 10.07.2015 from http://www.edis.sk/ekes/regions_finalreport_300505.pdf.

5. Foddi, M., & Usai, S. (2013). Regional Knowledge Performance in Europe. Growth and Change, Vol. 44, 2, 258–286.
6. Martin Prosperity Institute (2011) Creativity and Prosperity: The Global Creativity Index. Retrieved 15.07.2015 from http://martinprosperity.org/media/GCI-Report-reduced-Oct%202011.pdf.
7. The OECD Innovation Strategy: Getting a Head Start on Tomorrow (2010). Paris: OECD Publishing.
8. Regions and Innovation Policy (2011).OECD Reviews of Regional Innovation. OECD Publishing.
9. Draft Synthesis Report on Innovation Driven-Growth in Regions: The Role Of Smart Specialisation (2012). OECD. Retrieved 15.07.2015 from https://community.oecd.org/servlet/JiveServlet/download/20683-37253/Final_Draft_SmSp_0ECD_EC291112.pdf.
10. Saaty, Th.L. (2008-06). «Relative Measurement and its Generalization in Decision Making: Why Pairwise Comparisons are Central in Mathematics for the Measurement of Intangible Factors - The Analytic Hierarchy/Network Process». RACSAM (Review of the Royal Spanish Academy of Sciences, Series A, Mathematics), 102(2), 251–318. Retrieved 10.07.2015 from http://www.rac.es/ficheros/doc/00576.PDF.
11. Svetunkov, S.G. (2012). Complex-Valued Modeling in Economics and Finance. DOI 10/1007/978-1-4614-5876-0_1 Springer Sciense+Business Media New York.
12. National rating of investment climate in the subjects of the Russian Federation. Results 2015 (2015). Agency of strategic alternatives. Retrieved 17.07.2015 from http://asi.ru/regions/rating/.
13. Vnesheconombank SMEs are ready to grow. Development Bank (2014). Corporate Bulletin, 1(6). Retrieved 17.07.2015 from http://www.veb.ru/common/upload/files/veb/mag/2014_1.pdf.
14. SME Bank Statistics of lending to small and medium business in Russia (2015). VEB. Bulletin of the Analytical Center. Retrieved 17.07.2015 from http://www.mspbank.ru/userfiles/files/az/2015-05-statistika.pdf.
15. Hochberg, L.M., Gracheva, G.A., Ditkovskiy, K.A., Kirchik, O.I., Kovaleva, G.G., Kovaleva, N.V., et al. (2012) Ranking of innovative development of subjects of the Russian Federation: analytical report. L.M. Hochberg, Ed. Moscow: Higher School of Economics. Retrieved 17.07.2015 from http://www.hse.ru/primarydata/rir2012/.
16. Russian Federation Government Decree dated 17.11.2008 #1662-r "On the concept of long-term social and economic development of the Russian Federation for the period through to 2020."
17. Kiselev, V.N. (2010) Comparative analysis of innovative activity of the subjects of the Russian Federation. Innovations.
18. Rating of innovation activity of the regions of Russia 2010 (2011). NAIDIT. Official website of the National Association of innovation and development of information technology. Retrieved 17.07.2015 from http://www.nair-it.ru/news/17.05.2011/217.
19. Nedosekin, A.O. (2003). Methodological bases of modeling of financial activity using indistinctly-multiple descriptions (Doctoral dissertation). St. Petersburg. Retrieved 17.07.2015 from http://www.mirkin.ru/_docs/doctor005.pdf.
20. Social atlas of Russian regions. Index of innovativeness (2008). IISP. Official website of the Independent Institute for Social Policy. Retrieved 17.07.2015 from http://www.socpol.ru/atlas/indexes/index_innov.shtml#rating.
21. Rosstat Russian Regions. Social and economic indicators. Retrieved 17.07.2015 from http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156.
22. Parshukov, D.V. (2011). Tools for assessment of innovative potential of the agricultural organizations – Abstract of dissertation for the degree in economics. Krasnoyarsk. Retrieved 17.07.2015 from http://www.kgau.ru/new/aspirant/aspirantura/z2011/Parshukov%20D%20V.pdf.
23. Svetunkov, S.G. (2011). Fundamentals of complex-valued economy (pp. 348). St Petersburg: PE M.N. Vasilkina.