Marina I. Akhmetova[1]

ASSESSMENT OF TERRITORIAL INNOVATIVE SYSTEM DEVELOPMENT LEVEL WITHIN SOCIOECONOMIC ENVIRONMENT*

The author analyzes the performance of innovative and socioeconomic environment of a territory as a linear function. The paper presents the description of the logical link between indicators, mainly due to generation of all economic resources within socioeconomic environment. The factor scores for the estimation of territorial innovative potential have been identified and the integral indices has been calculated. The typological grouping of territories has also been formed. The obtained typology of Russian Federation regions allows taking into account the differences in the level of socioeconomic development as well as in the choice of priorities in the regional strategies. Regions' grouping by the level of innovative potential has been made on the base of the 2012 year data and by means of cluster analysis in "Statistica 10.0".

Keywords: *territorial innovative system; innovative potential; socioeconomic environment; factor score.*

Марина І. Ахметова

ОЦІНЮВАННЯ РІВНЯ РОЗВИТКУ ТЕРИТОРІАЛЬНОЇ ІННОВАЦІЙНОЇ СИСТЕМИ В ЇЇ СОЦІАЛЬНО-ЕКОНОМІЧНОМУ СЕРЕДОВИЩІ

У статті проведено аналіз показників розвитку інноваційного та соціально-економічного середовищ територій як лінійної функції. Описано логічний зв'язок між показниками, заснований на тому, що генерація всіх економічних ресурсів має місце в межах соціально-економічного середовища. Визначено систему показників для оцінювання регіонального інноваційного потенціалу, розраховано інтегральні індекси та на їх основі побудовано типологію регіонів. Отримана на прикладі регіонів Російської Федерації типологія дозволяє врахувати відмінності у рівнях соціально-економічного розвитку і, відповідно, у пріоритетах вибору регіональної стратегії. Групування регіонів виконано за даними 2012 р. з використанням кластерного аналізу у програмі "Statistica 10.0".

Ключові слова: *територіальна інноваційна система; інноваційний потенціал; соціально-економічне середовище; факторна оцінка.*

Форм. 2. Рис. 4. Табл. 4. Літ. 16.

Марина И. Ахметова

ОЦЕНКА УРОВНЯ РАЗВИТИЯ ТЕРРИТОРИАЛЬНОЙ ИННОВАЦИОННОЙ СИСТЕМЫ В ЕЁ СОЦИАЛЬНО-ЭКОНОМИЧЕСКОЙ СРЕДЕ

В статье проведен анализ показателей развития инновационной и социально-экономической среды территорий как линейной функции. Описана логическая связь между показателями, основанная на том, что генерация всех экономических ресурсов происходит в социально-экономической среде. Определена система показателей для оценки регионального инновационного потенциала, рассчитаны интегральные индексы и на их основе построена типология регионов. Полученная на примере регионов Российской Федерации типология позволяет учесть различия в уровне социально-экономического развития и, соответственно, в приоритетах выбора региональных стратегий.

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* The work has been financed by the Russian Humanitarian Scientific Fund (Project 14-12-59013). Работа выполнена при финансовой поддержке Российского гуманитарного научного фонда (проект 14-12-59013).

Группировка регионов выполнена по данным за 2012 г. с использованием кластерного анализа в программе "Statistica 10.0".

Ключевые слова: *территориальная инновационная система; инновационный потенциал; социально-экономическая среда; факторная оценка.*

Problem statement. Often in the world and domestic practice, we can observe the application of universal instruments of state policy in the field of innovation. However, there are significant differences between the territories in the level of socioeconomic development and, accordingly, in the choice of priorities of territorial strategies, due to the influence of various factors. Therefore, it seems critical to classify territories based on one or more criteria (the integral index). It will allow estimating the impact of specific factors and conditions of territorial innovative potential and to offer appropriate public policies at different levels of management hierarchy. Also, it will prevent the overgeneralization in management approaches to territorial innovative systems development.

Recent research and publications analysis. Theoretical and practical problems of national innovative system development have been presented in the works of C. Freeman (1995), J. Niosi et al. (1993), R. Nelson (1993), B-A. Lundvall (1992), A.A. Gretchenko (2014) and others. Moreover, the problems of basis for regional development are presented in the studies by J. Swords (2013), Y.K. Persky and Y.V. Kataeva (2010), M.I. Akhmetova et al. (2014), M.A. Afonasova (2009), A.I. Tatarkin and S.N. Kotlyarova (2013) and others. Estimation of innovative development of territories is considered in the studies by I.I. Eliseeva and P.A. Makarova (2010), I.M. Bortnik et al. (2012) and it is also in such leading national research institutes and international organizations as the World Intellectual Property Organization, the Global Innovation Agency, National Research University "Higher School of Economics" (Russia).

The main purpose of this study is to develop methodological approach to assess and group territories on the basis of their innovative potential, taking into account the differences in the level of socioeconomic development, as well as the choice of priorities of regional strategies.

Key research findings. Formation of an innovative system and investing in innovations are the two most important conditions for the development of any territory and this is universally recognized (Freeman, 1995; Lundvall, 1992; Gretchenko, 2014). However, scientists' opinions and ideas about the concept of territorial innovative system, conditions and factors of its efficient functioning and development are quite different (Afonasova, 2009). In this article territorial innovative system is understood as the complex developing system consisting of interconnected and interacting institutes. The main idea of this research consists in the fact that in today's conditions mutual influence of socioeconomic and innovative factors of different territories development becomes enhanced (Akhmetova et al., 2014). Moreover, wide use of innovations leads to the achievement of social and economic goals (Figure 1).

So, any territorial socioeconomic environment should create conditions for efficient realization of innovative processes, generation of knowledge and production innovative products and as a result stimulating high quality of human life, economic and innovative development of territories.

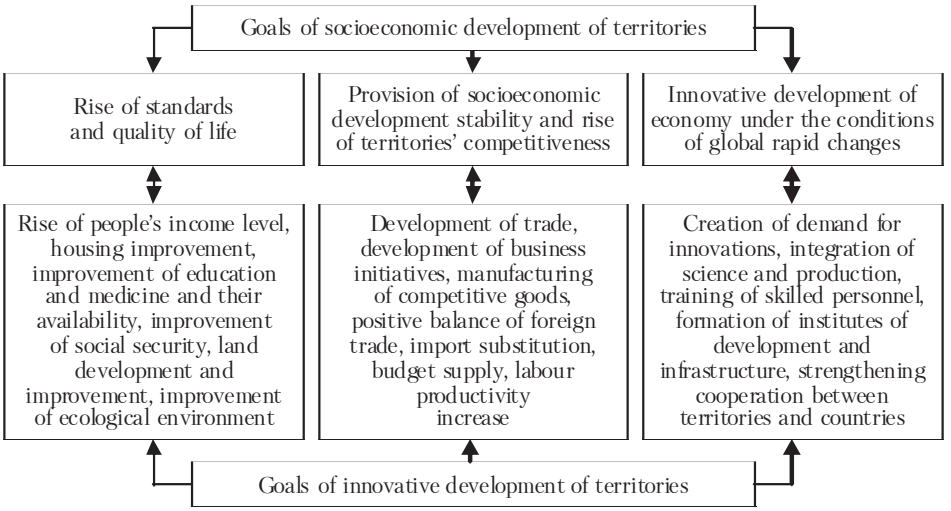


Figure 1. **Goals of socioeconomic innovative development of territories** (Persky and Kataeva, 2010)

Resources are not determinative for innovative development of a territory, but the presence of effective system of institutes is (Persky and Dubrovskaya, 2012; Tatarkin and Kotlyarova, 2013). It provides reasonable distribution of resources managed by the state. On the other hand, reasonably functioning system of institutes provides the reproduction of these resources, and also their quality increase when it is possible.

Creation of the innovative development strategy is the key task of different government levels. It should be mentioned here that subfederal (regional) innovative systems attract little attention from foreign and native authors (Swords, 2013) due to the fact that management of local innovative processes at the national level is complicated by the distance between central and peripheral territories and owing to a considerable degree of managerial approaches universalization. Along with federal states having subfederal territories under their jurisdiction, the problem of territorial innovative systems development level estimation as well as creation of innovative development strategies is urgent for unitary states, too. Thus, in the given research subfederal (subnational) formations are seen as sublevel territories within federal states and territories of low (local) level in the unitary states. Regarding our case the subjects of Russian Federation (RF) are subnational formations.

The basic approaches to the estimation of regional innovative development used in RF provide the complex of quantitative indicators on the basis of available statistics and measurements with the aim of their further aggregation into the integral index (innovative index) on the basis of which innovative regional development rating is formed (Eliseeva and Makarova, 2010; Bortnik et al., 2012). In relevant conditions quite informative results could be obtained using such rating. The difference between the approaches is founded in the choice of indicators composition. However, the considered approaches despite their substantial importance do not provide adequately the factor of mutual dependence of the innovative development level and the development of regions' socioeconomic environment. This does not make it possible to

qualify these approaches as system-oriented for the characteristic of the state and potential abilities of region's innovative development as well as to estimate the synergetic result.

On the one hand, the correlation between the innovative development level and socioeconomic environment of the region allows establishing the relation between the conditions of innovative development in the region, since the socioeconomic environment is the channel of resources for the regional innovative system. On the other hand, the level of regional innovative development stimulates its social and economic resources, involving them into innovative processes, generating and multiplying them in the specific innovative sector.

The state of socioeconomic environment of a region is closely associated with the quality of life of its population. At all levels of economy the guarantee of good quality of life of population, stable and competitive economic development, innovative development (as the condition of transfer to the postindustrial stage of development) are generalized in state.

Thus, it is necessary to take into account both indicators (the level of socioeconomic environment development and the level of innovative regional development) during the estimation of innovative potential (IP) of the region. The author has analyzed the indicators of innovative and socioeconomic environment development as the linear function $IP = (x;y)$, where x is the level of innovative environment development, y is the level of socioeconomic environment development.

To estimate the innovative potential of a region at the initial stage the calculation of integral indicators of innovative and socioeconomic environment development is carried out:

$$R_n = \sum_{1}^{n} X_{i'n}, \tag{1}$$

where n – a certain region; R_n – the integral indicator of n region; $X_{i'n}$ – the normalized value of i indicator on n region.

In contrast to most investigations the normalization of indicators is carried out not by linear ranging, but with the use of maximum or minimum values of the indicator selected from all the regions (formula 2), since the task of every region development is the achievement of maximum possible level of socioeconomic and innovative development which has already been achieved by some region.

$$X_{i'n} = \frac{x_{in}}{x_{i\max}} \text{ or } X_{i'n} = \frac{x_{in}}{x_{i\min}}, \tag{2}$$

where $X_{i'n}$ – the normalized value of i indicator on n region; x_{in} – the value of i indicator on n region; $x_{i\max}$ – the maximum value of i indicator selected from all the regions; $x_{i\min}$ – the minimum value of i indicator selected from all the regions.

The indicator's maximum value is used as standard for characteristics influencing positively the innovative or socioeconomic development (for example, average cash income per head). The minimum value is used for characteristics influencing negatively (for example, the number of traffic accidents per 100,000 persons). Territorial specific character is taken into account in this case, namely all the indicators are reduced to relative mode which allows avoiding errors in calculations due to considerable difference of regions' development conditions. Each factor of develop-

ment as well as the place of a region among others is estimated providing the reliability of the results. The list of indicators at the moment of analysis is considered to be exhaustive since the obligatory condition of basic data collection is their availability in all the regions in the corresponding year.

The system of indicators including the key aspects of socioeconomic development of the region is given in Table 1.

Table 1. **System of estimation indicators of the level of region's socioeconomic environment development (SEE)**

Factors	Indicators
1. Level of real income of population	1.1. (1)[1)] Real cash income, %
	1.2. (2) Cash income (average per head), RUB
	1.3. (3) Average monthly nominal wage and the level of subsistence minimum ratio, %
2. Housing conditions of population	2.1. (4) Total living space per one resident upon average, sq.m
	2.2. (5) Price index at private housing market, %
	2.3. (6) Price index at secondary housing market, %
3. Provision with social infrastructure objects	3.1. (7) Hospital accommodation per 10,000 persons, units
	3.2. (8) Income of social infrastructure objects, ths RUB
4. Environment and climate conditions	4.1. (9) The area of green space and plants in towns per 1000 citizens, ha
5. Residential safety	5.1. (10) Number of registered crimes per 100,000 persons, units a year
	5.2. (11) Number of dead per 10,000 of transport facilities
	5.3. (12) Number of traffic accidents per 100,000 persons
6. Development of business initiative	6.1. (13) Turnover of small businesses per head, ths RUB
7. Demographic situation	7.1. (14) Life interval expected at birth, years
8. People's health and level of education	8.1. (15) Number of doctors per 10,000 persons
	8.2. (16) Provision of preschool children with places in kindergartens, a number of places per 1000 children
	8.3. (17) Number of university students per 10,000 persons
9. Traffic infrastructure and the level of territorial development	9.1. (18) Relative density of motor roads with hard coating in the total extent of public motor roads, %
	9.2. (19) Density of public motor roads with hard coating (at the end of year; km of roads per 1000 sq.km of territory)
10. Level of economic development	10.1. (20) Share of economically active population in its total number, %
	10.2. (21) Unemployment level, %
	10.3. (22) Gross Regional Product (GRP) per head, %
	10.4. (23) Index of industrial production, %
	10.5. (24) Index of agricultural production, %
	10.6. (25) Retail trade turnover per head, RUB
	10.7. (26) Investments of basic capital per head in actually established prices
	10.8. (27) Share of export in foreign trade turnover, %
	10.9. (28) Share of organizations' profit tax funds in consolidated budget of RF subject per one citizen, ths RUB

[1)] Indicators' numbers are given in parentheses.

The system of indicators including the aspects of innovative development of the region (development of innovative environment) has the following form (Table 2).

On the basis of the proposed approach the multifactor estimation of socioeconomic and innovative development level of regions assumes the reduction of these indicators to dimensionless form taking into consideration the place of a region and the real value of the indicator in the interval from 0 to 1. All normalized indicators are

summarized. The integral indicator of socioeconomic development level may take a value from 0 to 28, since only 28 factors are used. The integral indicator of the innovative development level according to the number of the analyzed factors takes a value from 0 to 20.

Table 2. **System of indicators estimating the level of regions' innovative development – innovative environment (IE)**

Factors		Indicators
GENERATION	1. Level of science and education development	1.1. (1)[1)] Number of national research universities 1.2. (2) Number of PhD per 100,000 persons 1.3. (3) Number of Doctors of Science per 100,000 persons 1.4. (4) Number of organizations training postgraduates 1.5. (5) Number of postgraduates per 10,000 persons 1.6. (6) Number of organizations training doctoral candidates 1.7. (7) Number of doctoral candidates per 10,000 persons
IMPLICATION	2.Innovative development of organizations	2.1. (8) Share of organizations realizing technological innovations in the total number of organizations (innovative activity of organizations), % 2.2. (9) Number of organizations carrying out research and development work, unit per 10,000 persons 2.3. (10) Innovative activity of industrial organizations (share of industrial organizations realizing technological, organizational and/or marketing innovations in the total number of examined organizations) 2.4. (11) Number of personnel involved in R&D in the total number of persons engaged in economy, %
REFORMATION	3. Development of innovative economy	3.1. (12) Specific weight of innovative products, work, services in the total volume of shipped goods, performed work and services, % 3.2. (13) Specific weight of technological innovations costs in the total volume of shipped goods, performed work and services, % 3.3. (14) Correlation of innovative products, work and services volume and internal research and development costs, % 3.4. (15) Applications for patents (patents for invention, patents for models), units 3.5. (16) Granted patents (for inventions, for useful models, for production pieces), units 3.6. (17) Number of created advanced production technologies, units 3.7. (18) Number of realized advanced production technologies, units 3.8. (19) Share of technologies and technical services according to the value of receipts in Russian export, % 3.9. (20) Share of technologies and technical services according to the value of receipts in Russian import, %

[1)] Indicators' numbers are given in parentheses.

Grouping of the regions by the level of innovative potential has been carried out on the 2012 year data according to both criteria presented above and with the use of cluster analysis in "Statistica 10.0". Since the author didn't know the total number of clusters beforehand, the hierarchical algorithm was used as the method of clustering. Moreover, we proceed from the fact, that both criteria of regions' classification (IE and SEE integral indicators) are similarly important, so we used the Euclidean distance for equal consideration of differences according to criteria in the capacity of metric.

Clustering was carried out with the help of 7 hierarchical algorithms, namely by the method of "single connection", the method of "full connections", the method of "middle connection", by the weighted method of middle connection, by centroid method (non-weighted), by weighted centroid method and by the Ward method. All

the methods considered with the exception of Ward didn't give economically substantiated clustering, there were clearly defined clusters revealed. On the contrary, the Ward method made it possible to receive compact and well divided clusters which can be adequately interpreted economically. This method assumes the application of disperse analysis for measuring the distance between clusters. The sum of squares for any two (speculative) clusters which can be formed at every turn is minimized. The results of hierarchical classification by the Ward method is shown as an dendrogram in Figuire 2.

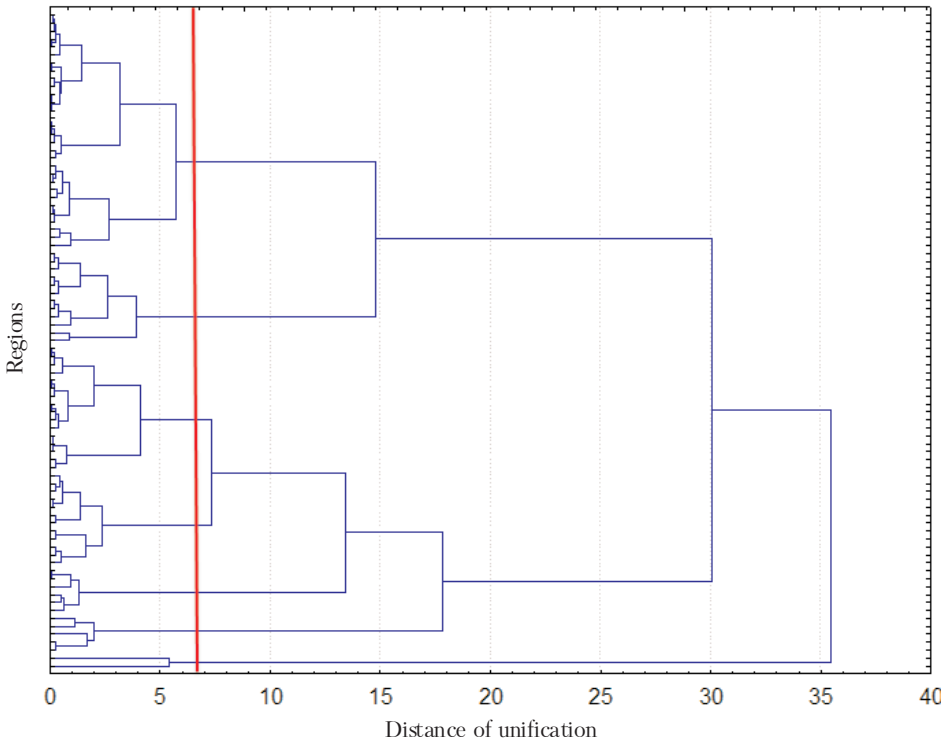


Figure 2. **Dendrogram for 83 regions of Russian Federation,** *author's development*

We used the diagram of unification process as the instrument for the choice of clusters' number according to which it is better to divide the analyzed RF regions (Figure 3).

Using the expert method we have chosen the distance equal to 6–6.5 units as the threshold distance. So we have got 7 clusters (the threshold distance is marked by the vertical line in Figure 2).

Table 3 presents the main quantitative characteristics of clusters (based on the Federal Service of State Statistics, 2012).

The place of a region by the level of its socioeconomic environment development and the level of innovative development in the given territory is shown in Figure 4. Data of the region's innovative development level is disposed on *x* axis, and the data of socioeconomic environment – on *y* axis. Dot diagram is built on the basis of this average estimation of every cluster.

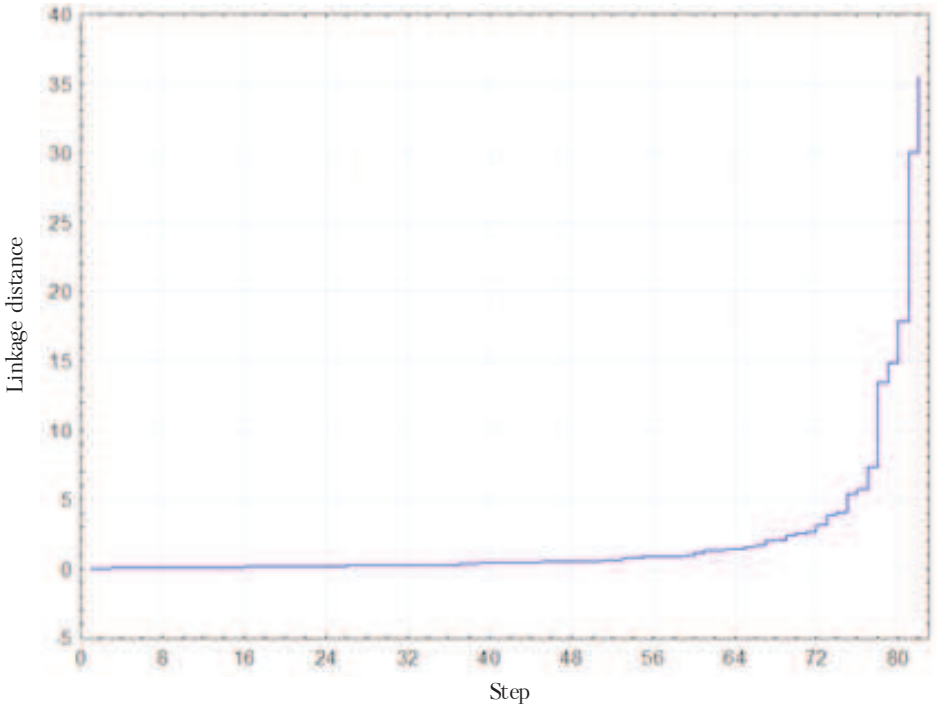


Figure 3. **The process of Russian regions unification into clusters,** *author's development*

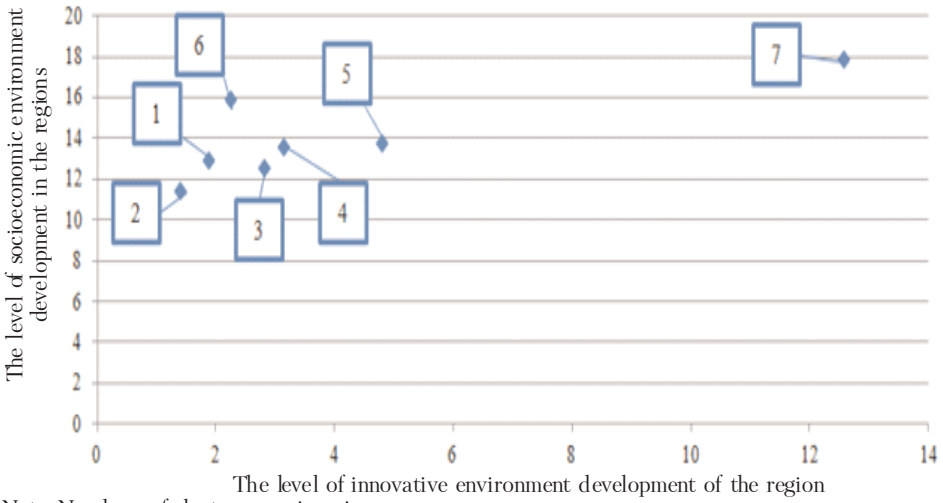
Table 3. **Quantitative characteristics of clusters,** *author's development*

Cluster's number	Number of regions in a cluster	Average value	Minimum value	Maximum value	Standard deflection
7	2	IE 12.55 SEE 17.90	IE 10.36 SEE 16.30	IE 14.75 SEE 19.49	IE 3.10 SEE 2.26
6	5	IE 2.23 SEE 16.00	IE 1.48 SEE 15.26	IE 3.29 SEE 16.96	IE 0.72 SEE 0.62
5	6	IE 4.78 SEE 13.79	IE 4.17 SEE 13.12	IE 5.08 SEE 14.17	IE 0.36 SEE 0.39
4	12	IE 3.11 SEE 13.63	IE 2.42 SEE 13.07	IE 3.89 SEE? 14.32	IE 0.42 SEE? 0.37
3	16	IE 2.80 SEE 12.65	IE 2.27 SEE 2.07	IE 3.64 SEE 13.14	IE 0.44 SEE 0.29
2	12	IE 1.36 SEE 11.50	IE 0.49 SEE 10.00	IE 2.42 SEE 12.18	IE 0.54 SEE 0.65
1	30	IE 1.85 SEE 12.98	IE 1.19 SEE 12.27	IE 2.35 SEE 14.52	IE 0.32 SEE 0.47

Final grouping of regions by the integral indicator of innovative potential is given below. Regions have been grouped into 7 clusters, and their strategic development status is briefly described (Table 4).

The seventh cluster includes only two regions and this fact remains stable with different approaches to clustering – Moscow and St.-Petersburg traditionally have unattainable for other regions position. Up to 80% of finance and 30% of labour resources are concentrated here which is very interesting for investors, innovators and

consumers of innovative products. On the assumption of essential content of the regional innovative system along the stages of its lifecycle the task of these regions is to conserve the raised potential and the rate of growth of their mature innovative systems.



Note: Numbers of clusters are given in squares.

Figure 4. **Distribution of Russian regions by the level of their innovative potential,** *author's development*

The sixth cluster includes the regions with high innovative potential, formed at the expense of development of socioeconomic environment, first of all. However, as cluster analysis of the regions show they are united by the sharp demand for attraction of manpower resources and low appeal for inhabitancy, which specifies the compensative character of state policy in these territories. The result of continuous "injection" of resources is the anomalously good indicators of socioeconomic development but very slow innovative development. So, the strategic task of the first priority in these regions is the search for solutions providing less outdoor assistance dependence and advancement of their own reserves of innovative development. Innovative decisions, in their turn, are able to increase investment attractiveness of these territories and create new places mobilizing investments and attracting people.

Innovative systems of the regions in the first and second clusters are at the stage of origin and formation, and they need to attract off-the-shelf solutions aimed at the management of economic innovative development. As we see in Figure 4 these regions have the lowest level of innovative environment development. They differ only by the level of socioeconomic factors development. So, their population standard of life is the decisive factor. This problem is more urgent for the regions of the second cluster than for the regions of the first one. But in any case all these regions can be considered as outsiders of the regional innovative movement in the long term.

The level of cumulative innovative potential of the regions in clusters 3, 4, and 5 is above average and so they stay in the zone of stable balanced development of innovative and socioeconomic environment. This fact denotes the presence of developing

innovative system, the ability of the regions to cooperate with highly developed territories and to adopt innovations.

Table 4. **Clustering of regions by to the level of their innovative potential,** *development by the author*

Cluster's number	Regions	Description of the level of innovative potential
7	Moscow city, St.-Petersburg city	**Very high** Strategy of conservation and stable development
6	Magadan Region, Nenets Autonomous Area, Tyumen region, Khanty-Mansi Autonomous Area, Yamal-Nenets Autonomous Area	**Great anomaly** (indicates artificial overstating of socioeconomic environment development level) Strategy of own reserves development
5	Moscow Region, Nyzhny Novgorod Region, Novosibirsk Region, Tatarstan Republic, Sverdlovsk Rgion, Tomsk Region	**High** Strategy of IE preservation and cooperation with the regions of clusters 7 and 4
4	Voronezh Region, Kamchatka Krai, Krasnodar Krai, Krasnoyarsk Krai, Lipetsk Region, Perm Krai, Bashkortostan Republic, Samara Region, Sakhalin region, Khabarovsk Region, Chelyabinsk Region, Yaroslavl Region	**Above average** Strategy aimed at the development of innovative environment and resources concentration, cooperation with cluster 5
3	Vladimir Region, Jewish Autonomous Region, Kaluga Region, Leningrad Region, Murmansk Region, Omsk Region, Orel Region, Primorye Territory, Adygei Republic, Buryat Republic, Mordovia Republic, Rostov Region, Saratov Region, Tver Region, Tula Region, Chuvash Republic	**Average** Strategy aimed at resort filling of innovative environment
2	Trans-Baikal Krai, Kabardino-Balkaria Republic, Karachai-Cherkess Republic, Kurgan Region, Pskov Region, Altai Republic, Dagestan Republic, Ingush Republic, Kalmyk Republic, Republic of Tuva, Khakass Republic, Chechen Republic	**Low** Strategy aimed at growth of resources necessary for the development of socioeconomic and innovative environment, cooperation with cluster 3
1	Altai, Amur Region, Archangel Region, Astrakhan Region, Belgorod Region, Bryansk Region, Volgograd Region, Vologda Region, Ivanovo Region, Irkutsk Region, Kaliningrad Region, Kemerovo Region, Kirov Region, Kostroma Region, Kursk Region, Novgorod Region, Orenburg Region, Penza Region, Republic of Karelia, Komi Republic,Mari-El Republic, Sakha Republic (Yakutia), North Ossetian Republic, Ryazan Region, Smolensk Region, Stavropol Krai, Tambov Region, Udmurt Republic, Ulyanovsk Region, Chukchi Autonomous District	**Below average** Strategy aimed at formation of innovative environment, cooperation with cluster 3

Conclusions. The author offers a methodological approach to assessing and grouping territories on the basis of their innovative potential. The considered approach provides the factor of mutual dependence of the innovative development level and development of regions' socioeconomic environment. The main characteristics of the regions in terms of innovation potential are given. It allows taking into account differences in the choice for priorities for regional strategies.

Directions for further research. Regions in clusters 3, 4, and 5 are the most interesting for factor analysis and strategic planning. In general, the presented clustering of regions could be considered as the basis for further research on strategic development of regions.

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Стаття надійшла до редакції 3.10.2014.