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Network Intelligence as a Necessity of the New Time

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Abstract

Realization of a modernization agenda requires improvement of competencies and intellectualization of territorial development of the management system in conditions of increasing uncertainty of the management situation and systemic risks. The purpose of our study was to analyze a spatial distribution of an intellectual potential of regions and propose a conclusion about leveling of risks from gaps in the economic space. We consider the following competencies as a basis of a potential that determines intellectualization of the management system. This is the ability to train personnel of HSQ and create and promote innovations. The factor analysis was used as a tool. The following conclusion was made: it is necessary to pay attention to development of national scientific schools because the education system is a basis for a formation of the competence economy. Moreover, it is necessary to stimulate development of the entire system of knowledge reproduction, and the entire space without gaps. The pandemic forced active development of digital platforms, transferring many spheres of public life. Opportunities for creating "the network intelligence" have increased. The need to improve competencies has increased, including development of a digital environment. It is possible to eliminate systemic risks that have arisen due to the gap in the economic space by strengthening collaborations based on digital platforms and forming "the network intelligence". The basic element of knowledge reproduction is training of qualified personnel at the university education system. Therefore, it is necessary to continue strengthening the integration and form collective models of the innovation process.

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1. Introduction

The fundamental basis of global changes taking place in the world is the formation of a qualitatively new type of economy. The main factor of development in it is an innovation and information. The knowledge economy has been actively studied in various aspects by many researchers'. Nevertheless, the term is still controversial despite the wide range of opinions. At least, it is used as a designation of a new form of the post-industrial economy (Al-Mubaraki & Busler, 2017; Becla, 2012; Gozhenko, 2012).

At the same time, it is not only about the large-scale technological modernization of the economy. It is also about the fact that in the context of development of the network and encryption economy and a formation of the information society, new threats and challenges are emerging. Ultimately, they are manifested in world-changing financial flows and in a distribution of economic benefits. By the way, the struggle for a participation

in the distribution of economic benefits begins with a possession of knowledge, with the struggle for intelligence and a competence that are protected by a legal (and other) force. The concentration of high technologies and personnel competencies is becoming key moments of the economy. It consists in the presence of a high creative potential and a level of intelligence. Besides, an equally important point is the ability to work analytically and critically with information. The basis of the knowledge economy is formed by infrastructure and technology technologies that form the circulation of knowledge and the information society in general. Moreover, accumulated human capital that ensures the sustainability of socioeconomic development of modern society formed the knowledge economy too.

The uncertainty of the management situation imposes increased requirements on the quality of management in a turbulent economy (essentially under stress). Therefore, in order to make decisions in conditions of uncertainty and overcome negative trends, it is necessary to take into account all following systemic risks and the subsequent stress. These include the quality of human capital. It is measured through a lack of competencies in this case.

In relation to the need to offset risks, it is worth talking about intellectualization of the management system for development of the territory (countries and their regions). That is why the purpose of our study was to analyze the spatial distribution of the intellectual potential of regions and to make a proposal for a conclusion about offsetting risks of identified space gaps. As the basis of this potential, which determines intellectualization of the control system, we consider the following competencies: the ability to train personnel of the highest scientific qualifications (HSQ) and to create and promote innovations.

2. Methodology and Methods

This research was based on the methodological basis of the economic theory, the new institutional and spatial economy. Besides, the study was carried out with extensive use of analytical tools. Statistics from the Federal State Statistics Service (FSSS) were used as a source of information (https://rosstat.gov.ru/folder/10705). The statistical analysis was carried out using the "Statistica" software.

Structural changes that occur during a crisis in the economy in a close connection with a transformation of the economic space have led to the need to understand systemic risk and to find causes and patterns of risk. The system analysis is used for this purpose. The algorithm for this analysis is shown in the Figure 1.

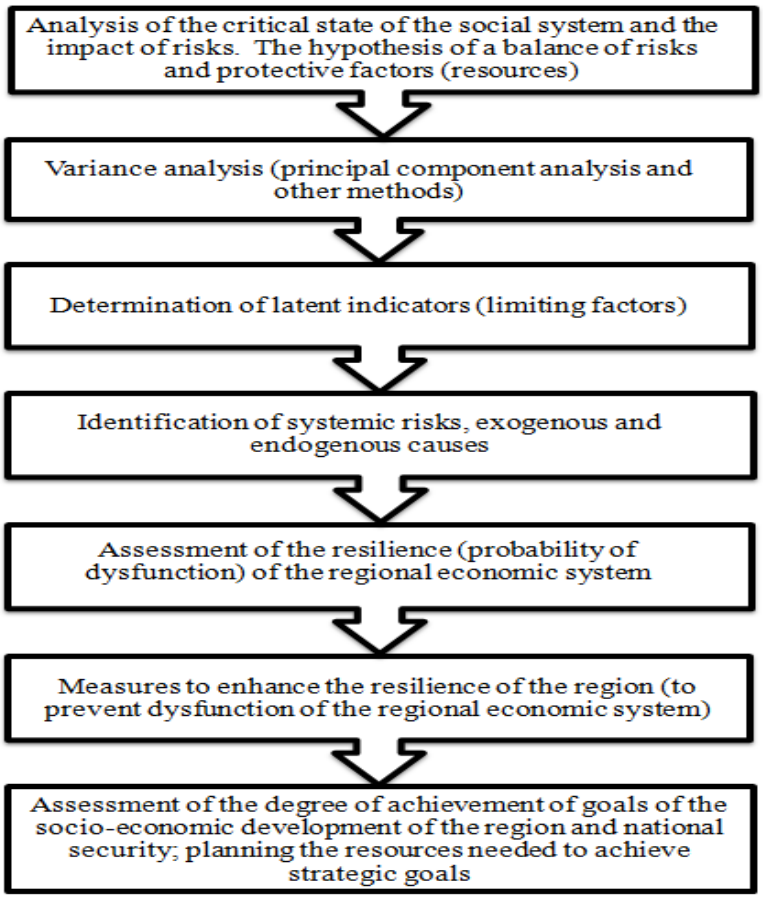

Figure-1. System analysis algorithm.

The term "systemic risk" in the financial environment is a risk in which an event can cause a loss of confidence, as well as a loss of economic parameters. These economic parameters accompany the growth of a significant part of the financial system. In turn, the system is so significant that it can have an adverse impact on a real sector of the economy (Report on Consolidation in the Financial Sector, 2001). The European Central Bank (ECB) views a systemic risk as the risk of occurrence and spread of a significant systemic event that negatively affects numerous system-forming agents and markets (Financial Stability Review, 2009). We assume that in the unstable economy, the concept of the "systemic risk" should expand the "financial" framework. In addition, it should become a broader and complex concept. This concept should consider the possibility of social regional systems to stress resistance based on understanding of endogenous causes (balance of extractive and inclusive institutions, institutional and social embeddedness, strategic interactions of agents, etc.) and the ability of the management system to make adequate decisions. According to E. Giddens's concept (Giddens, 1994), the existing institutional environment sets unified behavioral standards, thus creating collective risks. The term "risk society" is used in this sense. It replaces the society of production and distribution of goods, which is constantly accompanied by public production of risks (Beck, 2000).

Therefore, in addition to the traditional definition of systemic risk, we define it as a probability of a *dysfunction.* The probability of the dysfunction is a consequence of the action of a limiting factor. This factor leads to a deviation of the economic system from equilibrium and violates its structure or functions. At the same time, the adaptability to stress and limitations of the social system is revealed (and first of all, management systems). They are probably caused largely due to the imbalance of the regional institutional matrix.

We also assume that the lack of competencies (as a limitation of the management system) is a systemic risk. This system risk leads to a loss of confidence in the management system and the loss of socio-economic prospects of the region that arise within the framework of the contemporary modernization agenda.

The object of our research is the educational and innovative system of the region in accordance to the set purpose. We assume that its disadvantages (when they become essential) have an adverse effect on a quality of human capital and on the real sector of the economy. This happens through decline in an industrial and engineering culture as well as through decrease in the quality of decision-making corresponding to the turbulent economy.

The analysis of the world experience in development of indicators of sustainable development identifies two approaches to its understanding. The first approach is to identify indicators that reflect certain aspects of sustainable development. The second approach is to construct a complex indicator. This complex indicator reflects a degree of stability of socio-economic development of the region in general. In this case, the dysfunction is determined by the action of the limiting factor. It is instrumentally determined by grouping variables by their contribution to their total dispersion according to the algorithm Figure 1. Dispersion characterizes the measure of a risk, and the statistical analysis reflects some relationships between indicators of desired systems. We do not present theoretical explanations of the analysis here, because it can be found in a textbook on econometrics.

It is assumed that all observed changes in the values of statistical indicators are due to changes in some internal properties of the object – values of latent factors (calculated by the matrix of statistical indicators). With certain statistical assumptions about the nature of distributions of observed features in a certain interpretation, the factor acquires the meaning of introducing a latent variable. This variable determines values of observed features and the correlation between them that causes the presence of them. Obtained latent factors are indicators. According to their values, we classify objects (regions) according to the degree of influence of the factor and assess resilience of regions (first of all, the adaptive abilities of the management system).

3. Results and Discussion

The creation of the knowledge economy provides countries an intellectual and technological advantage over rest of the world and maintains a leading position in the formation of global public goods (Balcerzak & Pietrzak, 2016). This emphasizes the relationship between education, science and innovation and economic development of the country.

Education is the foundation of economic and innovation development. Nowadays, the current state and development of modern higher education and training of personnel of HSQ as one of the main factors influencing the level and rates of socioeconomic growth of regions and countries in general is actively discussed (Rizvi, 2012; Schleicher, 2007; Slepak, 2015).

Countries, where higher education was developing at a faster rate, also had higher rates of economic growth (Rizvi, 2012). Also there is a correlation between GDP and results of innovation activity. This is demonstrated in the Figure 2, which shows dynamics of countries grouped by GDP level (from high to low). In addition, another trend is emerging. It is expressed in the desire of countries with above-average incomes to actively engage in the innovation sphere. They increase R&D funding, but lose out in efficiency to high-income countries.

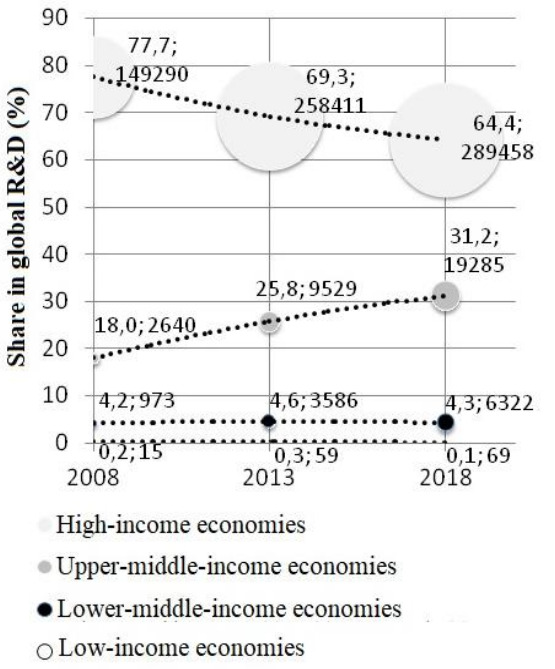

Figure-2. Changes in global indicators.
Data Signatures: «Share in global R&D» and «Number of granted patents (USPTO)» (bubble size).
The Source: UNESCO Science Report: Towards 2030 – Executive Summary (2015); UNESCO Science Report: The Race against Time for Smarter Development (2021).

Realities of globalization and growing international interdependence require increased competencies. Most importantly, they require the expansion of the area of regional competencies. Therefore, understanding importance of the educational system, a major state of supporting programs of leading educational institutions were implemented and continue to be implemented in Russia during the period 2000-2019. Their goal is to increase the competitiveness of the Russian education and the science sector, as well as to improve the quality of an educational process to an international level. At the same time, according to E. Sivak, some elite institutions are not what can be judged on opportunities and prospects of the scientific and educational sphere in general. It is because leading organizations will not be able to fully develop on their own, isolated from rest of it. In this regard, first of all, while evaluating organizations, such quantitative indicators as the number and quality of published material, the amount of funds allocated for research and development, and so on should be taken as a basis (Sivak, 2013). Secondly, in conditions of uncertainty, it is necessary to support development of the entire economic space, but not just its individual parts.

However, unfortunately it is not possible to predict what changes next few decades will bring with them, but there is a chance to predict what will stimulate these changes (Rizvi, 2012). The latter can be understood by assessing the stress resistance (resilience) of regions through the ability of regions to self-organize in educational and innovation spheres against a background of existing regulatory reasons for the transformation of the economic space.

The concept of sustainability postulates a long-term civilization strategy. At the same time, chaotic and rapid growth of changes threatens serious trials today. The modern management situation requires not only an adequate response, but overcoming difficulties with minimizing risks. Therefore, researchers began to pay attention to such phenomenon as a social resistance (sustainability). It is defined as the ability of communities to withstand stresses and disorders that occur as a result of social and other changes. At the same time, it does not lose the ability to self-organize and minimize losses, timely adapts its structure to risks (Adger, 2000; Adger, 2007).

As a working hypothesis, we propose a statement on a balance of risks and protective factors and a balance of the social system: there are limited institutional and social factors that limit social systems adaptation to stresses. Social resilience in general as well as its individual components, such as limits and effectiveness of adaptation to stresses, depend on the degree of uncertainty regarding a risk foresight, a risk balance and a protective factor (resource) of the social system in its economic, cultural and other dimension. As a result of geopolitical, geoeconomic, social (including medical) transformations, practically all spheres of the society have been affected by stresses. The question of how much do mesoeconomic systems able to effectively respond to management methods to increasing systemic risks becomes extremely relevant.

Then we tested this hypothesis. We investigate the period 2000-2019, because during this period our society found itself under the pressure of stresses due to various causes. The following indicators are selected for the analysis:

x1 – population (people).

x2 – number of personnel engaged in research and development (people).
x3 – number of researchers with a scientific degree (people).
x4 – internal costs for research and development (million rubles).
x5 – number of students enrolled in undergraduate, specialist programs and graduate programs per 10,000 population (people).
x6 – number of graduate students (people).
x7 – number of doctoral students (people).
x8 – granted patents for inventions and utility models.
x9 – used advanced production technologies.
x10 – developed advanced production technologies.
x11 – innovative activity of organizations (%).
x12 – volume of innovations (million rubles).
x13 – GRP per capita (million rubles).
x14 – share of investments in fixed assets per capita of GRP (%).
x15 – revenues of the consolidated budgets of the constituent entities of Russian Federation per capita (million rubles).
x16 – share of state debt of constituent entities of Russian Federation from GRP (%).

Profiles of macroregions (federal districts) in the measurement of above-mentioned indicators are shown in the Figure 3 Indicators are calibrated in order to put them on the same graph and compare federal districts with each other in the measured area.

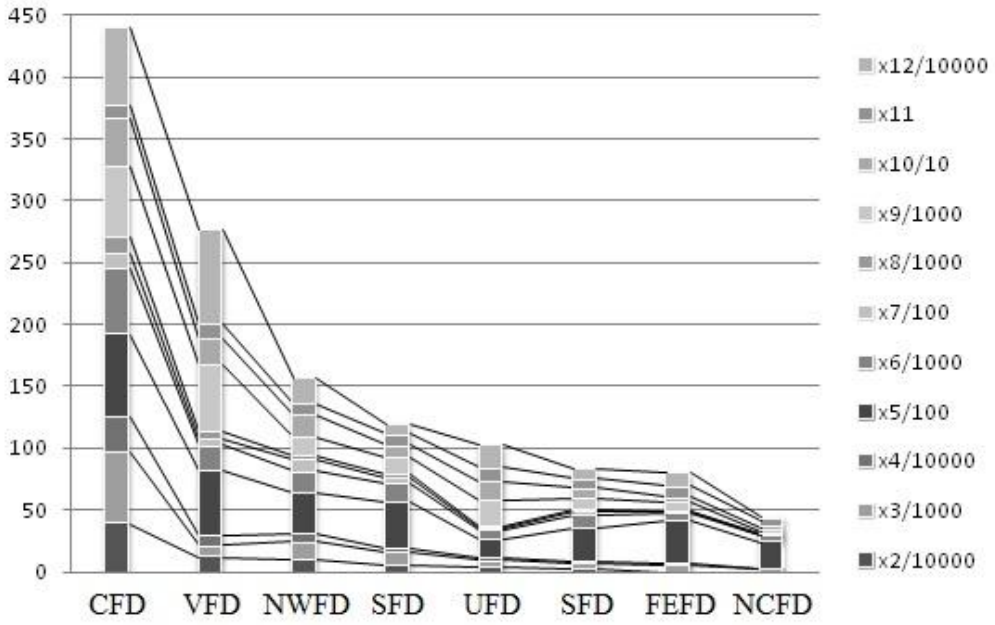

Figure-3. Educational and innovative profile of macroregions (federal districts) (average indicators for 2000-2019). CFD – Central Federal District, VFD – Volga Federal District, NWFD – North-Western Federal District, SFD – Siberian Federal District, UFD – Ural Federal District, SFD – Southern Federal District, FEFD – Far Eastern Federal District, NCFD – North Caucasus Federal District.

Data from the period 2000-2019 demonstrate the socioeconomic differentiation of Russian regions in terms of the educational and innovation potential. According to indicators that characterize the sphere of education in each macroregion it can be observed that the Central Federal District stands out against eight federal districts, as it includes Moscow. The second place is occupied by the Volga Federal District. In third place is the North-Western Federal District and St. Petersburg, which is part of it. Of course, the volume of a production of values matters. However, it is necessary to check how balanced the system of social relations is.

In order to assess resilience of regions, a study of the structure of relations in the educational and innovative sphere was conducted. At the same time, due to multicollinearity, we cannot estimate the exact value of each indicator separately. "Multicollinearity" is a linear dependence of indicators on each other. To eliminate the problem of multicollinearity, it is necessary to use methods to reduce the number of explanatory indicators. This is done by switching to latent factors. For example, the method of factor analysis is used. It is aimed at studying patterns of changes in dispersion of economic indicators and assessing the dimension of variables by studying correlation matrices. At the same time, we move from n indicators to $m<n$ factors with the highest dispersion. Obtained factors, in contrast to initial indicators, are orthogonal, i.e. their correlations are zero. These factors have the property of the least distortion of the geometric structure of source data when moving to a space of a smaller dimension.

The result of the factor analysis is presented in the Table 1.

Table-1. The matrix of factor loads of indicators of education and innovation potential of Russian regions for 2000-2019.

Variable	Latent factors		
	1	2	3
Population (people)	0.68	0.13	0.58
Number of personnel engaged in research and development (people)	0.92	0.12	0.31
Number of researchers with a scientific degree (people)	0.95	0.15	0.17
Internal costs for research and development (million rubles)	0.93	0.13	0.29
Number of students enrolled in undergraduate. specialist programs and graduate programs per 10.000 population (people)	0.73	-0.12	0.12
Number of graduate students (people)	0.96	0.12	0.19
Number of doctoral students (people)	0.90	-0.01	0.11
Granted patents for inventions and utility models	0.94	0.12	0.27
Used advanced production technologies	0.51	-0.02	0.72
Developed advanced production technologies	0.82	0.08	0.42
Innovative activity of organizations (%)	0.30	-0.15	0.69
Volume of innovations (million rubles)	0.61	0.08	0.66
GRP per capita (million rubles)	0.40	0.65	0.31
Share of investments in fixed assets per capita of GRP (%)	-0.34	0.57	-0.21
Revenues of the consolidated budgets of the constituent entities of Russian Federation per capita (million rubles)	0.40	0.73	-0.05
Share of state debt of constituent entities of Russian Federation from GRP (%)	-0.05	-0.41	-0.59
Expl. Var.	8.04	1.60	2.77
Prp. Totl.	0.50	0.10	0.17

The main assumption of the factor analysis is that correlations between numerous observed variables are determined by the existence of fewer hypothetical observed factors. As a result of the analysis of the presented sample, three significant independent factors were identified, explaining more than 77% of dispersion of observed variables.

The first factor (50 % of dispersion) is related to educational indicators, as well as the volume of innovation and the use of technology. It is identified as the volume of competencies interpreted as the ability to develop competence in creating innovations. This volume is necessary for sustainability.

The second factor (10%) is a measure of economic growth. It is associated with the following indicators: "gross regional product (per capita)", investment and budget. It is identified as the volume of made values. In other words, it is the ability to effectively regulate the production of values and the use of resources.

The third factor (17%) is related to debts of the subject of Russian Federation (feedback) and population, as well as to indicators that characterize the innovation sphere. It is identified as the optimal regulation based on the balance of risk and resources (including reflected in effectiveness of the implementation of innovations).

Further, in order to analyze endogenous causes of the imbalance of social systems, we considered dynamics of measurable variables in different periods, differing conditions of functioning of systems.

Changes in factor loads of the following variables are practically unchanged:

- Number of personnel engaged in research and development.
- Number of researchers with a scientific degree.
- Internal costs for research and development.
- Number of graduate students.
- Granted patents for inventions and utility models.

However, the factor 1 has the greatest influence on them.

The largest change was shown by the population variable, the used advanced manufacturing technologies variable and the volume of innovation variable. The value of their loads grew until the period 2010-2015, after which there was decline.

Also a strong variation is observed at variables of the number of students, the number of doctoral students, the innovative activity of organizations, revenues of consolidated budgets of constituent entities of Russian Federation per capita. Despite the negative trend until 2010-2015, this factor has a favorable effect on them after this period.

The factor 1 has the least influence on load indicators of the share of investments in fixed assets per capita of GRP and the share of state debt of constituent entities of Russian Federation from GRP. Their values practically did not change throughout the entire period of time.

A stable positive trend (of the influence of the factor 2) throughout the considered period of time is observed in the variable of the share of investments in fixed assets per capita. Also, growth of the trend is shown by variables GRP per capita and revenues of consolidated budgets of constituent entities of Russian Federation per capita. They have seen growth followed by slight decline since 2010-2015.

Negative dynamics can be seen in variables of population, used and developed advanced production technologies, the innovative activity of organizations and the volume of innovations. However, their values have stabilized from 2010-2015.

Variables of the number of personnel engaged in research and development, internal costs for research and development, the number of graduate students, the number of doctoral students, granted patents for inventions and utility models are practically unchanged throughout the considered period of time.

Steady decline (of influence of the factor 3) over the entire period of time is visible in variables of revenues of consolidated budgets of constituent entities of Russian Federation per capita and the share of state debt of constituent entities of Russian Federation from GRP. On the contrary, a positive trend throughout the entire period is visible in variables of the number of personnel engaged in research and development, granted patents for inventions and utility models, used and developed advanced production technologies and the volume of innovations.

Sharp decline and same sharp rise are observed in variables of GRP per capita and the share of investments in fixed assets per capita of GRP. They are negatively correlated with the following variables:

- Number of students.
- Number of graduate students.
- Number of doctoral students.
- Innovative activity of organizations.

They are characterized by sharp rise and same sharp decline.

Of course, the power of a particular factor and endogenous resources that increase the value of a particular indicator is important. At the same time, such a seemingly inconspicuous reason as the state of a control system has been identified. It is based on an existing institutional matrix. This matrix contains opportunities and limitations in use of endogenous resources. Many researchers have noted that a significant role is played by selection of "right" institutions in order to minimize costs and to maximize benefits of an effective industrial policy and externalities of information and knowledge flows between all participants of such an industrial policy (Agrawal, Cckburn, & Rosell, 2010; Rodrik, 2004; Tolstoguzov, 2018). Ultimately, the system of social relations is based on a certain institutional matrix. According to this matrix, the economic order is determined, the distribution of resources, capital and other results of the economic process carried out (Tolstoguzov, 2018). Therefore, on the example of one of Russian regions (Republic of Karelia), the authors conducted an institutional analysis of a regional strategic portfolio. As a result, inconsistencies and contradictions that have arisen between strategic planning and economic and spatial realities have been identified. In regional strategies, the region is represented as a mechanical system with the reproduction of technologies and labor and with the processing of natural resources. The logic of this approach leads exclusively to the production specialization of the region and to attention to the action of the factor 2 and to fluctuations in values of indicators.

We assume that the desired social system may be in a non-equilibrium state. However, this state is due not to the influence of external factors, but to the fact that disequilibrium originates endogenously (Arthur, 2015).

Our one-factor analysis of dispersion (significance level α=0.05 and a significant Fisher criterion) showed that the calculated *P*-value was less than the value of α. In this case, the type of connections is determined by non-Gaussian. “Non-Gaussian” is a mismatch with the normal distribution. Besides, other properties in the statistical sample of parameters appear. In particular, the irreducibility of the average statistical value to the mathematical expectation appears. Therefore, the occurrence of a situation of instability in the case of objects we are considering depends on endogenous factors. It is necessary to apply the factor analysis and identify latent factors to assess them.

A matrix of factor loads of objects (regions) in terms of education and innovation potential for 2000-2019 was calculated to assess resilience of regions. Three factors are identified, which have more than 90% of the total dispersion together (respectively, 61%, 12%, 21%).

The final general matrix was divided by macro-regions into separate Tables 2-9 due to the large size of the table. Together they make up a common table.

Table-2. Matrix of factor loads of regions of Central Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Belgorod Region	1.00	-0.04	0.15
Bryansk Region	0.97	0.06	0.22
Vladimir Region	0.84	0.05	0.52
Voronezh Region	0.73	0.09	0.66
Ivanovo Region	0.66	0.55	0.41
Kaluga Region	0.50	0.06	0.85
Kostroma Region	0.97	0.08	0.07
Kursk Region	0.92	0.03	0.39
Lipetsk Region	0.99	-0.06	0.12
Moscow Region	0.75	-0.02	0.67
Orel Region	0.89	0.18	0.30
Ryazan Region	0.89	0.09	0.44
Smolensk Region	0.92	0.13	0.29
Tambov Region	0.87	0.13	0.42
Tver Region	0.83	0.05	0.54
Tula Region	0.95	-0.02	0.31
Yaroslavl Region	0.89	0.00	0.46
Moscow	0.51	-0.01	0.86

Table-3. Matrix of factor loads of regions of Volga Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Republic of Bashkortostan	0.97	-0.02	0.25
Republic of Mari El	0.97	0.09	0.20
Republic of Mordovia	0.99	-0.05	0.15
Republic of Tatarstan	0.98	-0.07	0.18
Udmurtian Republic	0.98	-0.03	0.16
Chuvash Republic	0.97	0.01	0.20
Perm Territory	0.97	-0.06	0.24
Kirov Region	0.89	0.02	0.38
Nizhny Novgorod Region	0.83	-0.05	0.55
Orenburg Region	0.98	0.08	0.16
Penza Region	0.66	0.12	0.73
Samara Region	0.97	-0.06	0.25
Saratov region	0.72	0.17	0.56
Ulyanovsk Region	0.86	-0.02	0.50

Table-4. Matrix of factor loads of regions of North-Western Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Republic of Karelia	0.50	0.42	0.69
Komi Republic	0.95	0.00	0.30
Arkhangelsk Region	0.98	-0.02	0.19
Arkhangelsk Region	0.99	-0.04	0.12
Kaliningrad Region	0.76	0.23	0.58
Leningrad Region	0.74	0.08	0.67
Murmansk Region	0.71	0.11	0.68
Novgorod Region	0.93	0.02	0.31
Pskov Region	0.59	0.42	0.10
Saint Petersburg	0.71	-0.03	0.70

Table-5. Matrix of factor loads of regions of Siberian Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Republic of Altai	-0.03	0.82	0.03
Republic of Tuva	-0.21	0.76	0.58
Republic of Khakassia	0.31	0.86	-0.06
Altai Territory	0.88	0.24	0.37
Krasnoyarsk Territory	0.90	-0.02	0.41
Irkutsk Region	0.70	0.23	0.66
Kemerovo Region	0.96	0.15	0.19
Novosibirsk Region	0.42	0.09	0.89
Omsk Region	0.79	0.10	0.58
Tomsk Region	0.45	0.05	0.89

Table-6. Matrix of factor loads of regions of Ural Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Kurgan Region	0.89	0.25	0.29
Sverdlovsk Region	0.91	-0.03	0.41
Tyumen Region	0.97	-0.05	0.24
Chelyabinsk Region	0.87	0.01	0.49

Table-7. Matrix of factor loads of regions of Southern Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Republic of Adygea	0.97	0.18	0.16
Republic of Kalmykia	-0.08	0.84	0.08
Krasnodar Territory	0.93	0.10	0.34
Astrakhan Region	0.83	0.34	0.43
Volgograd Region	0.94	0.06	0.34
Rostov Region	0.88	0.04	0.46
Republic of Crimea	0.07	0.67	0.67
Sevastopol	0.14	0.36	0.92

Table-8. Matrix of factor loads of regions of Far Eastern Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Republic of Buryatia	0.84	0.31	0.43
Republic of Sakha (Yakutia)	0.78	0.12	0.61
Trans-Baikal Territory	0.96	0.19	0.16
Kamchatka Territory	-0.05	0.21	0.94
Primorye Territory	0.47	0.20	0.85
Khabarovsk Territory	0.98	-0.02	0.19
Amur Region	0.87	0.32	0.37
Magadan Region	0.84	0.00	0.44
Sakhalin Region	0.99	-0.08	0.13
Jewish Autonomous Region	0.07	0.67	-0.10
Chukotka Autonomous Area	0.24	-0.20	-0.14

Table-9. Matrix of factor loads of regions of North Caucasus Federal District in terms of education and innovation potential for 2000-2019.

Regions	Latent factors		
	1	2	3
Chukotka Autonomous Area	-0.06	0.87	0.29
Republic of Ingushetia	-0.09	0.97	-0.11
Kabardino-Balkarian Republic	0.32	0.74	0.55
Karachayevo-Circassian Republic	0.68	0.48	0.54
Republic of North Ossetia - Alania	-0.18	0.89	0.39
Chechen Republic	0.07	0.94	0.07
Stavropol Territory	0.98	0.05	0.20

As a result of the matrix analysis, clustering of regions was carried out. Means for grouping objects is a scattering diagram of variables and observations on the factor axis. Then, fuzzy sets that characterize different degrees of influence of latent factors were identified using the method of a simple factor structure. Let there be a set of objects $E=(\varepsilon_1, \varepsilon_2, \varepsilon_3, \ldots \varepsilon_{82})$ and characteristic functions μ_l, that allow us to distribute objects into fuzzy sets

$$A_j = [\varepsilon_i, \mu_l(\varepsilon_i)],$$

where $\mu_l(\varepsilon_i) = (0; 1)$, $l=1,2,3$, $j=1\ldots10$, $i=1\ldots82$, $\mu_l(\varepsilon_i) = 0{,}5$ – transition point.

Table-10. Grouping of Russian regions (by the fuzzy set criterion) and ranking of their resilience.

Cluster	Regions (fuzzy sets of objects)	Rank
$\mu_l(\varepsilon_i) > 0{,}5$		
1 *(l=1)*	**Moscow, St. Petersburg**; Belgorod Region, Bryansk Region, Vladimir Region, Voronezh Region, Ivanovo Region, Kaluga Region, Kostroma Region, Kursk Region, Lipetsk Region, Moscow Region, Orel Region, Ryazan Region, Smolensk Region, Tambov Region, Tver Region, Tula Region, Yaroslavl Region, Region, Vologda Region, Kaliningrad Region, Leningrad Region, Murmansk Region, Novgorod Region, Pskov Region, Astrakhan Region, Volgograd Region, Rostov Region, Kirov Region, Nizhny Novgorod Region, Orenburg Region, Penza Region, Samara Region, Saratov Region, Ulyanovsk Region, Kurgan Region, Sverdlovsk Region, Tyumen Region, Chelyabinsk Region, Irkutsk Region, Kemerovo Region, Novosibirsk Region, Omsk Region, Tomsk Region, Amur Region, Magadan Region, Sakhalin Region; Republic of Karelia, Komi Republic, Republic of Adygea, Karachayevo-Circassian Republic, Republic of Bashkortostan, Republic of Mari El, Republic of Mordovia, Republic of Tatarstan, Udmurtian Republic, Chuvash Republic, Republic of Buryatia, Republic of Sakha (Yakutia); Krasnodar Territory, Stavropol Territory, Perm Territory, Altai Territory, Krasnoyarsk Territory, Trans-Baikal Territory, Primorye Territory, Khabarovsk Territory	3
2 *(l=2)*	Ivanovo Region, Pskov Region; Republic of Karelia, Republic of Kalmykia, Republic of Crimea, Republic of Daghestan, Republic of Ingushetia, Kabardino-Balkarian Republic, Karachayevo-Circassian Republic, Republic of North Ossetia – Alania, Chechen Republic, Republic of Altai, Republic of Tuva, Republic of Khakassia; Jewish Autonomous Region	4
3 *(l=3)*	**Moscow, St. Petersburg, Sevastopol**; Vladimir Region, Voronezh Region, Ivanovo Region, Kaluga Region, Moscow Region, Ryazan Region, Tambov Region, Tver Region, Yaroslavl Region Kaliningrad Region, Leningrad Region, Murmansk Region, Astrakhan Region, Rostov Region, Nizhny Novgorod Region, Penza Region, Saratov Region, Ulyanovsk Region, Sverdlovsk Region, Chelyabinsk Region, Irkutsk Region, Novosibirsk Region, Omsk Region, Tomsk Region, Magadan Region; Republic of Karelia, Republic of Crimea, Karachayevo-Circassian Republic, Kabardino-Balkarian Republic, Republic of Tuva, Republic of Buryatia, Republic of Sakha (Yakutia); Krasnodar Territory, Kamchatka Territory, Primorye Territory	3
4 *(l=1; 2)*	Ivanovo Region and Pskov Region, Republic of Karelia and Karachayevo-Circassian Republic	2
5 *(l=1;3)*	**Moscow, St. Petersburg**; Vladimir Region, Voronezh Region, Ivanovo Region, Kaluga Region, Moscow Region, Ryazan Region, Tambov Region, Tver Region, Yaroslavl Region, Kaliningrad Region, Leningrad Region, Murmansk Region, Astrakhan Region, Rostov Region, Nizhny Novgorod Region, Penza Region, Saratov Region, Ulyanovsk Region, Sverdlovsk Region, Chelyabinsk Region, Irkutsk Region, Novosibirsk Region, Omsk Region, Tomsk Region, Magadan Region; Republic of Karelia, Karachayevo-Circassian Republic, Republic of Buryatia, Republic of Sakha (Yakutia); Krasnoyarsk Territory, Primorye Territory	1
6 *(l=2;3)*	Kaluga Region and Ivanovo Region; Republic of Karelia, Karachayevo-Circassian Republic, Kabardino-Balkarian Republic, Republic of North Ossetia – Alania, Republic of Tuva and Republic of Crimea	2
7 *(l=1;2;3)*	Ivanovo Region, Republic of Karelia and Karachayevo-Circassian Republic	1
$\mu_l(\varepsilon_i) < 0{,}5$		
8 *(l=1;2)*	Chukotka Autonomous Area; Kamchatka Territory; **Sevastopol**	5
9 *(l=1;3)*	Republic of Kalmykia, Republic of Daghestan, Republic of Ingushetia, Republic of North Ossetia – Alania, Chechen Republic, Republic of Altai,, Republic of Khakassia; Jewish Autonomous Region; Chukotka Autonomous Area	
10*(l=2;3)*	Chukotka Autonomous Area	

The Table 10 shows groupings – fuzzy sets selected by the method of simple factor structure. A measure of proximity or a criterion for cluster formation (a fuzzy set A_j) is a measurement of the Euclidean distance that exceeds the threshold value. It must exceed the threshold value (in other words, it is the probability of falling into the "center" of the cluster). The Euclidean distance is determined by the scale of factor loads.

The analysis also showed the following pattern, which is implemented in most regions. This is the fact that the ability to regulate lags behind the ability and capacity to produce values. In fact, there is an imbalance in the management system in terms of synchronizing of the volume of values produced and the ability to be regulative. This leads to the fact that either there are not enough competencies to implement all produced innovations, or some of them go outside (to other regions and countries) as a result of the diffusion of innovations (the term was introduced by Hägerstrand (1967). In our opinion, the best situation is in the unit elasticity (balanced growth of factors 1 and 3) in this case.

Also the Table 10 shows results of ranking clusters by the degree of resilience. It is based on the balance of the influence of latent factors. The rank 1 means the best balance. Then its decrease is reflected as the number of rank increases. At the same time, the rank 5 shows the state of complete imbalance of the control system in the system of coordinates under consideration.

On the one hand, the growing scale of production of quality values is certainly important, especially in the phase of a steadily growing market. On the other hand, optimization of resource use is required in turbulent conditions. Therefore, it is important to coordinate efforts of all interacting actors and systematically approach the existing institutional matrix. This matrix is a system of strategic regulators of the functioning of regions in a single portfolio "strategy → state programs → budget".

We consider that the differentiation of regions by the rank reflects the state of resilience of social systems. The main reason that generates collective risks in the "risk society" (Beck, 2000) is the state of the institutional environment (setting unified behavioral standards (Giddens, 1994). We can assume this taking into account previously formulated judgments about endogenous causes of systemic risks and discussions of obtained results. So it is important to diagnose the institutional matrix (the balance of extractive and inclusive institutions, institutional and social roots, strategic interactions of agents, etc.).

The conducted institutional analysis of the portfolio of state programs of one of the regions showed an unsystematic and palliative nature of introduced institutions of regional management. And this is despite the fact that this region is successful, i.e. balanced in comparison with other regions. In particular, a discrepancy between goals, priorities, and targets of programs was revealed. Moreover, there is a lack of coordination at a cross-intersection of programs and at an effective communication system between all subjects of public life. More than that, there is an insufficient level of competence of document developers. Therefore, it is necessary to introduce the principle of coordination (with the controlling function) of institutions and subjects in addition to establishing and regulating principles for the formation of the institutional matrix. All this will lead to a coordinating effect of institutions. It will manifest a decrease in the level of uncertainty of the environment in which subjects operate. Also, all this will lead to increase in resilience of the region and prevent the dysfunction of the management system.

4. Conclusion

The genesis of the innovative activity of territories should be sought in the explanation: who, where and how carries out educational and innovative activities. A spatial model has been formed: an innovation and educational *center* and a *periphery* lagging behind it in terms of competencies. The center satisfies needs of the periphery for an intellectual resource (innovation and human resources) through the diffusion of an intellectual resource to some extent. At the same time, such geography of innovation activity imposes serious increase in transaction costs on the periphery (Tolstoguzov, 2018). Besides, restrictions of regions in competencies for development of innovations and training personnel (Tolstoguzov, 2016) reduce adaptive abilities of the management system and resilience of territories in general.

It should be taken into account that geography of formed cross-border knowledge flows (relocation of researchers, rights to inventions and other intellectual objects) and the emergence of new trends depend on institutional factors. Also they depend on the balance of the institutional matrix. At the same time, leaders and the periphery have different quality of institutes of the innovation process that ensure the protection of interests of participants in innovation activities. The works (Tolstoguzov, 2016; Tolstoguzov, 2018) show that the reason for this is the legal, informational and digital discrimination of the periphery imposed by extractive market institutions. This discrimination of the periphery leads to the loss of economic rent. Developed geo-economic entities (countries and regions) seek to become owners-licensors. They strive to provide ready-made technologies and information products to peripheral licensees for a high intellectual rent (royalties). So the high efficiency provided by these rules in creating innovations reflects the greatest competence in innovation activity and in creating a portfolio of rights to the industrial value.

The concentration of an intellectual potential (including the competence of the HSQ personnel and the spatial placement of innovations) is associated with such a concept as "externalities of knowledge". An attention to the spatial development as a manifestation of the synergy of space has increased due to this conception.

A model of the knowledge economy is formed as a result of synergy. To be more precise, this is the economy of competencies, the implementation of which is accelerated due to the digital economy and the strengthening of digital inequality, synchronization and integration of information and financial infrastructures, as well as the state of the educational sphere. Spatial externalities of knowledge and regulatory mechanisms of transactions strengthen the "power" center (the licensor of technologies and the beneficiary of the created value) and weaken the periphery (as a licensee who is technologically dependent on the center).

Based on the above circumstances it is important not only to correctly diagnose the situation of regions and the country in general in the system of knowledge production, but also to eliminate systemic risks that have arisen to form an effective "network intelligence". These systemic risks are caused by the rupture of the economic space due to the strengthening of collaborations based on digital platforms.

The economic space has become more permeable in the modern globalizing world. The mobility of streams has increased. Interdependence of subjects has increased. The range of economic activities has expanded. This was greatly facilitated by development of telecommunications and networks. Humanity has entered a new world of communications – the "Internet galaxy" (Castels, 2004). Network thinking and network society were formed under the influence of development of network structures (Castels, 2000).

This advantage is more actively used by countries in accordance with their level of development (GDP). The Figure 4 shows the use of the Internet in the groups of countries under consideration. High-income countries have more developed infrastructure and technologies for development of network intelligence. This proves once again that they strive to become licensors, providing ready-made technologies and information products to peripherals for a very decent royalty.

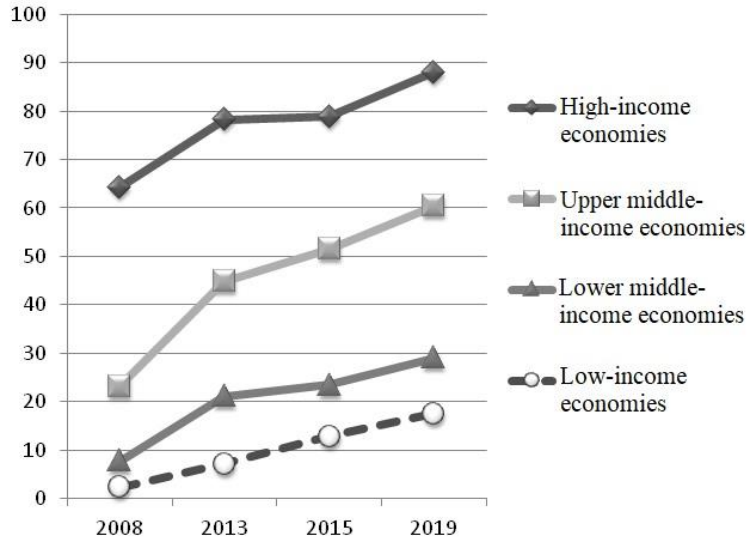

Figure-4. Internet users per 100 population.
The Source: UNESCO Science Report (2016, 2021).

Thus, development of a new economy leads to intellectualization of management, which provides innovative processes and unique solutions. This corresponds to the concept of a "global factory" (Grunwald & Flamm, 1985). All this radically changes the global division of labor. Besides, it promotes the diffusion of innovations. The diffusion of innovations occurs under the condition of compliance of educational and innovation systems in the institutional, organizational and competence senses. At the same time, different countries and regions have completely different prerequisites for development of the educational and innovative sphere and strengthening their resilience.

Therefore, it is necessary to develop a model of interaction between innovative agents based on an understanding of the situation. The purpose of this is to obtain the benefits of externalities of the knowledge economy by influencing allocation contradictions of the existing geography of educational and innovative activity. Society has shown new opportunities to establish new forms of collaboration in the context of the covid pandemic. This is due to network platforms and other Internet capabilities. In particular, this was actively implemented in the field of education.

The pandemic forced active development of digital platforms, transferring many spheres of public life to them. In particular, opportunities for creating "network intelligence" have also increased (the collective model of the educational and innovative environment). Consequently, the need to improve competencies in development of the digital environment has increased.

Considering the above, the collective model of the educational and innovative environment should be implemented in the following areas:

The first direction is to eliminate digital discrimination and develop an information exchange infrastructure to change the information permeability of the economic space (to form the proximity of elements). This means that it is necessary to implement measures for the physical association of agents (by improving the information infrastructure) and also for the creation of a collective information model. The physical movement of people is being replaced by the movement of messages due to the introduction of information and communication technologies. In addition, we assume that agents receive information about each other's capabilities and intentions through close information exchange (so that the capabilities and intentions of each of the agents become known to all other agents) and they form their own mental models. There is an intersection of mental models, and a collective model of the innovation environment is being created due to such information exchange online. The collective model allows not only to recreate a relativistic picture of the economic world with non-zero information permeability of the agent interaction environment, but also to correct the picture and synchronize their actions and expectations.

The second direction is to change the information permeability of the economic space. This should be done by creating institutional means necessary for the interaction of agents and ensuring their institutional proximity. It is necessary to change institutional structures in order to change the social reality. The latter, in turn, affect means of communication and the exchange of information and, ultimately, economic exchanges. The reason is the fact that actions of agents and economic results are synchronized by a system of correct incentives.

This creates favorable conditions for the concentration of intellectual potential and its transformation into a synergy of space. Universities are turning into international institutions as a basis for collaboration, as shown by the example of Arctic universities (Pitukhina, 2018).

The formation of an innovative economy is quite a difficult task. At the same time, the formation of this type of economy is possible only with an increase in the quality of human capital, It is necessary to constantly stimulate innovative activity and improve human capital in order to ensure this. At the same time, it should be not only by improving the competence approach, but also by regulating the flow of knowledge and migration of HSQ personnel, by developing institutions that stimulate innovation and reduce discrimination against agents, by developing scientific schools and by conducting a systematic policy based on the strategy of modernization of the country and elimination of discrimination of participants in the innovation market. The basic element of knowledge reproduction is the training of qualified personnel in the university education system. Therefore, on their basis, it is necessary to continue strengthening integration and forming collective models of the innovation process (network intelligence).

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