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CONNECTIVITY MATRIX OF REGION'S SUBPOTENTIALS AS A TOOL FOR MANAGING ITS COMPETITIVENESS

This paper suggests a scientific and methodological approach to identifying the prospective directions in increasing region's competitiveness, based on determining the connections between goal-setting and goal-achieving subpotentials of competitiveness and formation of the connectivity matrix. This methodology is tested on evaluating the connectivity of Leningrad region's subpotentials (its territorial characteristics are comparable to those of some European countries) and, in the authors' opinion, can be successfully used for shaping an effective regional policy.
Keywords: *region; region's potential; competitiveness; connectivity matrix.*
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МАТРИЦЯ ЗВ'ЯЗНОСТІ СУБПОТЕНЦІАЛІВ РЕГІОНУ ЯК ІНСТРУМЕНТ УПРАВЛІННЯ ЙОГО КОНКУРЕТНОСПРОМОЖНІСТЮ

У статті представлено науково-методичний підхід до виявлення перспективних напрямків підвищення конкурентоспроможності регіону, що спирається на встановлення зв'язків цілепокладаючих та цілереалізуючих субпотенціалів конкурентоспроможності та формування матриці зв'язків. Ця методика була апробована на основі оцінювання зв'язності субпотенціалів Ленінградської області Російської Федерації (чиї територіальні характеристики можуть бути порівняні з низкою європейських країн) і, на думку авторів, може бути успішно використана для розробки ефективної регіональної політики.
Ключові слова: *регіон; потенціал регіону; конкурентоспроможність; матриця зв'язності.*
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МАТРИЦА СВЯЗНОСТИ СУБПОТЕНЦИАЛОВ РЕГИОНА КАК ИНСТРУМЕНТ УПРАВЛЕНИЯ ЕГО КОНКУРЕНТОСПОСОБНОСТЬЮ

В статье представлен научно-методический подход к выявлению перспективных направлений повышения конкурентоспособности региона, основанный на установлении связей целезадающих и целереализующих субпотенциалов конкурентоспособности и формировании матрицы связей. Данная методика была апробирована на основе оценки связанности субпотенциалов Ленинградской области Российской Федерации (чьи территориальные характеристики сравнимы с рядом европейских стран) и, по мнению авторов, может быть успешно использована для разработки эффективной региональной политики.
Ключевые слова: *регион; потенциал региона; конкурентоспособность; матрица сязности.*

Introduction. Qualitative changes in today's world economy are closely related to the processes of globalization, integration, internationalization, stronger competition at all levels: international, national and regional ones, as well as to the changing paradigm of social development – transfer to innovation and investment development. This results in the need to search for the ways to increase socioeconomic systems'

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competitiveness at all levels, including the regional one, given the specifics and current development trends.

In case of the resource and production-based approach, regions are viewed mostly as subjects of economic relations, a bearer of specific economic properties and interests in reference to other regions.

Transfer to innovation and investment-based development strengthens the significance of qualitative parameters and features not only because it involves intellectual assets, but also because it helps social aspects of national and regional economies to evolve. Innovation- and investment-based approaches call for a stronger role of human and intellectual capital. Competition between regions is becoming more and more fierce, competitive advantages of regions are governed not only by the results of socioeconomic development but also by a capacity to ensure sustainable economic (for investors) and social (for the public) security in future, which creates foundations for further region's development.

Since competitiveness of a region characterizes its capabilities to compete successfully with other regions for resources, investments, markets, the general approach to competitiveness evaluation can be based on evaluation of individual potentials (subpotentials) of a region. This is the reason why development of a scientific and methodological approach to identifying prospective trends for increasing region's competitiveness, based on determining the ties between goal-setting and goal-achieving subpotentials of competitiveness and formation of the connection matrix, seems to the authors as one of the important issues to tackle in today's regional economy.

Literature review. Today competition at the mesolevel is increasing (between regions, territorial economic sectors), which is caused by intensification of manufacturing processes. Expansion of interregional competition is related to the capabilities to use the territory for satisfaction of population's complex needs, including those of the highest level. Territory of a region is becoming not only the basis for material production development, but also a place for formation, development and use of human capital, application of innovations, satisfaction of population's needs in public goods, recreation, participation in non-commercial organizations etc.

Theoretical foundation of competition and competitiveness of territories and industries was studied by many researchers, including N.V. Afanasyeva and A.V. Sirotkin (2009), L.A. Anosova (2010), B. Asheim and M. Gertler (2004), M.B. Grinchel (2013).

Under the conditions of transition to innovative economy much attention is paid to researching the innovation and investment constituents of regional development, which has an important significance for the growth of region's competitiveness, in particular, by such researchers as A.I. Balashov (2003), L. Botazzi and G. Peri (2003), M.A. Gusakov et al. (2014), S.V. Kuznetsov and O.N. Iakovleva (2005), D.G. Rodionov (2012), D.G. Rodionov et al. (2000), A.A. Rumyantsev et al. (2000), V.V. Yanovsky (2006) and others.

At the same time, despite a lot of the relevant research, when forming a complex approach to evaluation of national economies' and their regions' competitiveness, an integrative character of innovation and investment policy of a region is not considered adequately, as well as interrelation of this policy and region's competitiveness. No

doubt, it makes the present research important from the scientific and practical points of view.

Problem statement and research objective. A hypothesis can be made that region's competitiveness potential is marked not only by the presence of some subpotentials, their development level, qualitative or quantitative certainty, but also by the degree of their connectivity. If zero and maximal connectivity level are excluded, apparently, competitiveness potential will depend on some level of connectivity of each subpotential with the following one.

The objective of this research is to show that connectivity of two heterogeneous potentials generates synergy effects due to intercommunication of subpotential with their system based on joint flows of energy, material and information.

Key results. For the purposes of this research let us discuss the concept of potential as such. This term is common and widely used as a complex of conditions, means, capabilities, resources, which can be brought into action in future to achieve the set goals (Prokhorov et al., 1991: 562–563). At the same time, the vision of the structure and type of potentials can be different. Scientific literature separates spiritual and material potentials, accumulated resource potential (Misko, 1991), unifying individual subpotentials mostly of economic nature (at the same time, spiritual potential, potential of non-urbanized territories is not taken into account).

In our opinion, constituents of potential must be defined through the concept of subpotential.

Subpotential is a major part of potential, which has relative independence, is governed by its laws of functioning, development, its own principles of organization etc. At the same time region is seen as an integrity which has a certain property of connectivity while subpotentials form a distinct system.

Let us use an approach to formation of regional potential as a system of region's subpotentials, developed in literature (Sadykov, 2014). This approach has been developed in respect to formation of regional potential of the investment and construction sector. In addition, we distinguish financial potential because in relation to investment potential it has certain specifics, which will be reviewed by us in more detail further.

Region's most important subpotentials are presented in Figure 1.

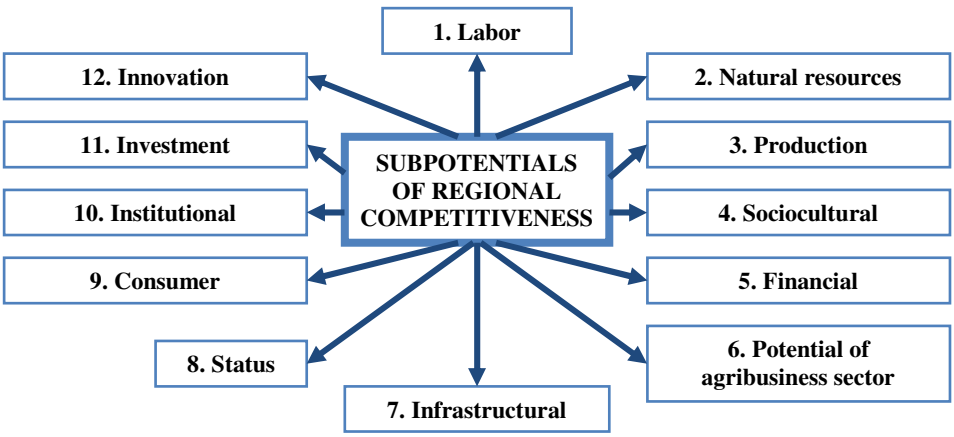

Figure 1. **Structure of region's subpotentials,** *authors'*

We would like to clarify the content of each subpotential in terms of the objective of this research and formulate the methodological principles for distinguishing competitiveness subpotentials:

- each subpotential has to express a certain form of material, physical, economic, and financial contents;
- all subpotentials together create a basis for existence of unified regional systems, including the system of regional competitiveness;
- as a whole they have to be a uniform regional system functioning according to the laws which are qualitatively different from the existence laws of each subpotential;
- each subpotential is characterized with its own laws, trends, principles of development, management system etc.

In different regions, one or another subpotential gets the prevailing development; in agricultural regions – agribusiness sector, in industrial regions – production subpotential; in regions with developed science and education – staff training and retraining, tourism, health resorts. However, between all subpotentials there are certain connections, which form and develop, such as cultural, ethnical, social, and confessional ones. As a whole, connectivity between these subpotentials can be described with a conditional degree of connectivity, which, in theory, can have two values; zero connectivity level, i.e. the absence of any connection between subpotentials, which is unlikely in real life. A conventionally maximal connectivity level (100%) equals to one when all subpotentials are so rigidly interconnected that they have no relative independence at all.

In formation of synergy effects an important role is played by vertical and horizontal connections and interactions between economic agents at all levels. The following ones act as integration tools: the mission, the system of respective goals and objectives, similarity of institutional forms, methods, tools and control levers.

When reviewing the possible ways of integration and further formation of synergy potential of regional competitiveness, it should be noted that these processes are based on establishing rational (optimal) connectivity between the structures and functions of a region.

It is obvious that if connectivity equals zero, there is no interaction between elements or systems, integration is exceptional and a positive synergy effect is absent. If connectivity is maximal (conventionally equals one), then an element, subsystem of an economic agent loses the necessary freedom of operation and the integration function takes a clearly negative form (Sadykov, 2014).

Thus, integration effect (and, consequently, a possible synergy effect) in a system is a function of, at least, two variables:

- functional and structural development of each interacting element (subsystem);
- connectivity level between elements.

It is worth adding that evaluation of the functional development level of constituents implies certain quantitative assessments, including, for example, production volume in a region, number of introduced innovative products etc.

Let us formulate other assumptions as well.

- each subpotential is connected with one another;
- connectivity is a property (with numerical values of connectivity level);

- if connectivity equals 0, there is no interaction;
- if connectivity equals 1, there is no degree of freedom;
- connectivity degree depends on the development level and interaction forms of each subsystem or each element;
- the higher is the connectivity degree (up to certain limits), the higher would be the development level of each subpotential.

Connectivity level or interaction, or interpenetration of subpotentials marks certain synergy processes (it is possible to distinguish when new qualities of interacting potentials are generated). According to the connectivity theory of two objects there is such a value of connectivity for each present moment whereby efficiency of their interaction (synergy effect) reaches its highest value. Connectivity of two heterogeneous potentials generates certain synergy effects, preconditioned by interaction of each subpotential with their system based on joint flows (energy, material and information ones), which act as a whole.

In order to determine competitiveness of a region, let us put forward a hypothesis: if there is connection between elements (subpotentials) of a region, the level of connectivity is most important in revealing region's competitiveness.

Since it does not seem possible to express heterogeneous potentials with some common units, an attempt can be made to express synergy effect through a connectivity system of all potentials. The authors put forward a hypothesis that if the system of potentials exists, it is possible to build a connectivity matrix of each potential with every another potential.

It is recommended to build the connectivity matrix of subpotentials using to the following method:

1. To select a group of experts in the field of regional competitiveness who have sufficient expertise to provide evaluations (from 0 to 1) of pair connection of competitiveness subpotentials. Evaluations are to be given both in reference to the current state and to the projected values.

2. Determination of the variation range. In the reviewed series of values, the vibration amplitude (of the variation range R) is set, which represents the difference between extreme values of variation range:

$$R = X_{\max} - X_{\min}, \tag{1}$$

where $X_{\max}$, $X_{\min}$ are the maximal and minimal values of the variation range correspondingly.

3. Determination of mean-square deviation. When calculating the mean-square deviation it is possible to use an approximation method by peak-to-peak variation range amplitude via the coefficient K, calculated by the number of observations from 2 to 1000. The mean-square deviation (σ) can be determined by formula:

$$\sigma = \frac{(X_{\max} - X_{\min})}{K} = \frac{R}{K}. \tag{2}$$

When calculating the mean-square deviation, it is reasonable to try to decrease the σ-value. That is why, if in the number of observations there are individual points which precondition a big value of the mean-square deviation, such points can be excluded. Thus, for example, if extreme numbers are included in experts' responses, the second pair of experts can be excluded from further analysis. At the same time, of

course, the number n must be reduced. When calculating the numerator reduces faster than the denominator, so σ parameter comes out much lesser.

4. Determination of mean-square deviation error. At the next step, the error of the mean-square deviation is calculated:

$$m = \frac{\sigma}{\sqrt{n-1}}. \quad (3)$$

This formula implies that m to a larger extent depends on σ, rather than on n. Thus, to reduce an error by an order of magnitude, there is the need for either coordination in experts' opinions (decrease in the range) by an order of magnitude or increase in the number of experts by two orders of magnitude.

5. Determination of the arithmetic mean value of characteristic. The arithmetic mean value of the characteristic is determined by the formula:

$$M = \sum_{i=1}^{n} \frac{X_i}{n}, \quad (4)$$

where n is the number of observations (the number of experts).

6. Connectivity matrix of region's subpotentials is built based on the data about the arithmetic mean value of the characteristic and the error of the mean-square deviation. A group of specialists in the relevant field was attracted to participate in this experiment, which included 5 Doctors of Sciences and 5 PhDs in Economics. Based on the calculated concordance coefficient, equal to 0.39, and upon evaluation of its significance according to the Pearson criterion (42.62 with the significance level equal to 0.05) it can be concluded that the obtained results make sense and can be used for further research.

Expert evaluations on Leningrad Oblast data have been processed using the proposed methodology to construct the connectivity matrix of subpotentials in this region for the year 2015 and also for the projected year 2020 (Tables 1 and 2).

Conclusions. The following conclusions are made from this research:

1. This study shows that to ensure competitive advantages of territories requires the formation of a regional innovation and investment policy, which should include the unity of 3 policy types mutually adapted to each other. However, till now principles and criteria for integration have not been formulated clearly enough. This study proposes to use a matrix, which defines each policy as goal-setting and goal-reaching, and takes into account the differentiation of subjects, economic interests, goals and objectives, implementation principles. In this matrix each goal-setting policy is associated with the system goal-reaching policy that justifies the identification of opportunities and constraints during its implementation (execution).

2. From Table 1 it follows that the coefficients of connectivity are insignificant, apparently due to insufficient level of socioeconomic development of Leningrad region. However, the forecast for the year 2020 (Table 2) shows that the level of connectivity of competitiveness potentials is twice higher than the level in 2015, which testifies to the necessity for transition to innovative-investment development path.

3. Table 1 shows that labor potential must be considered as a goal-setting one, while goal-reaching innovation potential is provided only by 30% with labor potential. Today the training system of professional working personnel is not developed enough in the region. For example, there are sophisticated aggregates in hospitals

Table 1. **Concluding matrix of regional subpotentials connectivity, 2015,** *authors'*

Goal-setting potential	**Goal-reaching potential**												
	1. Innovation potential	2. Labor potential	3. Natural resources potential	4. Consumer potential	5. Production potential	6. Institutional potential	7. Status potential	8. Financial potential	9. Investment potential	10. Sociocultural potential	11. Infrastructure potential	12. Agribusiness sector potential	**Mean value**
1. Innovation potential		0.29±0.03	0.22±0.03	0.30±0.02	0.30±0.03	0.24±0.03	0.32±0.04	0.29±0.04	0.28±0.04	0.24±0.03	0.26±0.04	0.21±0.04	0.27±0.04
2. Labor potential	0.29±0.03		0.28±0.03	0.32±0.02	0.31±0.03	0.32±0.02	0.30±0.02	0.32±0.02	0.30±0.02	0.28±0.03	0.32±0.03	0.26±0.03	0.30±0.03
3. Natural resources potential	0.22±0.03	0.28±0.03		0.24±0.03	0.31±0.02	0.24±0.03	0.26±0.03	0.27±0.03	0.29±0.03	0.30±0.02	0.29±0.03	0.30±0.02	0.27±0.03
4. Consumer potential	0.30±0.02	0.32±0.02	0.24±0.03		0.35±0.02	0.27±0.02	0.32±0.02	0.32±0.02	0.31±0.02	0.31±0.03	0.29±0.03	0.30±0.03	0.30±0.03
5. Production potential	0.30±0.03	0.31±0.03	0.31±0.02	0.35±0.02		0.28±0.02	0.28±0.04	0.34±0.02	0.29±0.04	0.25±0.03	0.36±0.03	0.28±0.04	0.30±0.03
6. Institutional potential	0.24±0.03	0.32±0.02	0.24±0.03	0.27±0.02	0.28±0.02		0.28±0.03	0.27±0.03	0.27±0.03	0.27±0.02	0.30±0.05	0.29±0.04	0.28±0.03
7. Status potential	0.32±0.04	0.30±0.02	0.26±0.03	0.32±0.02	0.28±0.04	0.28±0.03		0.27±0.03	0.29±0.03	0.25±0.03	0.35±0.03	0.24±0.03	0.29±0.03
8. Financial potential	0.29±0.04	0.32±0.02	0.27±0.03	0.32±0.02	0.34±0.02	0.27±0.03	0.27±0.03		0.29±0.04	0.29±0.02	0.30±0.03	0.22±0.03	0.29±0.03
9. Investment potential	0.28±0.04	0.30±0.02	0.29±0.03	0.31±0.02	0.29±0.04	0.27±0.03	0.29±0.03	0.29±0.04		0.26±0.01	0.29±0.04	0.27±0.02	0.29±0.03
10. Sociocultural potential	0.24±0.03	0.28±0.03	0.30±0.02	0.31±0.03	0.25±0.03	0.27±0.02	0.25±0.03	0.29±0.02	0.26±0.01		0.20±0.02	0.22±0.03	0.26±0.03
11. Infrastructural potential	0.26±0.04	0.32±0.03	0.29±0.03	0.29±0.03	0.36±0.03	0.30±0.05	0.35±0.03	0.30±0.03	0.29±0.04	0.20±0.02		0.25±0.03	0.29±0.04
12. Agribusiness potential	0.21±0.04	0.26±0.03	0.30±0.02	0.30±0.03	0.28±0.04	0.29±0.04	0.24±0.03	0.22±0.03	0.27±0.02	0.22±0.03	0.25±0.03		0.26±0.03
Mean value	0.27±0.04	0.30±0.03	0.27±0.03	0.30±0.03	0.30±0.03	0.28±0.03	0.29±0.04	0.29±0.03	0.29±0.04	0.26±0.03	0.29±0.04	0.26±0.03	

Table 2. **Concluding matrix of projected regional subpotentials connectivity, forecast for 2020,** *authors'*

Goal-setting potential	**Goal-reaching potential**												
	1. Innovation potential	2. Labor potential	3. Natural resources potential	4. Consumer potential	5. Production potential	6. Institutional potential	7. Status potential	8. Financial potential	9. Investment potential	10. Sociocultural potential	11. Infrastructure potential	12. Agribusiness sector potential	**Mean value**
1. Innovation potential		0.60±0.06	0.51±0.03	0.61±0.05	0.59±0.05	0.54±0.03	0.49±0.03	0.57±0.08	0.53±0.05	0.50±0.05	0.56±0.04	0.53±0.04	0.55±0.05
2. Labor potential	0.60±0.06		0.49±0.02	0.62±0.02	0.64±0.04	0.53±0.04	0.50±0.05	0.58±0.06	0.58±0.03	0.50±0.02	0.60±0.04	0.56±0.04	0.56±0.04
3. Natural resources potential	0.51±0.03	0.49±0.02		0.54±0.03	0.58±0.03	0.48±0.03	0.46±0.05	0.51±0.05	0.59±0.03	0.57±0.04	0.56±0.04	0.58±0.04	0.53±0.04
4. Consumer potential	0.61±0.05	0.62±0.02	0.54±0.03		0.66±0.04	0.51±0.04	0.56±0.05	0.51±0.05	0.58±0.03	0.51±0.04	0.55±0.05	0.59±0.04	0.57±0.04
5. Production potential	0.59±0.05	0.64±0.04	0.58±0.03	0.66±0.04		0.60±0.05	0.55±0.03	0.60±0.06	0.59±0.04	0.48±0.04	0.67±0.03	0.56±0.04	0.59±0.04
6. Institutional potential	0.54±0.03	0.53±0.04	0.48±0.03	0.51±0.04	0.60±0.05		0.60±0.03	0.51±0.08	0.57±0.04	0.51±0.04	0.58±0.04	0.55±0.05	0.55±0.05
7. Status potential	0.49±0.03	0.50±0.05	0.46±0.05	0.56±0.05	0.55±0.03	0.60±0.03		0.56±0.08	0.55±0.06	0.58±0.04	0.63±0.03	0.57±0.06	0.56±0.05
8. Financial potential	0.57±0.08	0.58±0.06	0.51±0.05	0.51±0.05	0.60±0.06	0.51±0.08	0.56±0.08		0.57±0.03	0.52±0.04	0.59±0.03	0.54±0.04	0.56±0.04
9. Investment potential	0.53±0.05	0.58±0.03	0.59±0.03	0.58±0.03	0.59±0.04	0.57±0.04	0.55±0.06	0.57±0.03		0.51±0.04	0.57±0.04	0.54±0.04	0.56±0.05
10. Sociocultural potential	0.50±0.05	0.50±0.02	0.57±0.04	0.51±0.04	0.48±0.04	0.51±0.04	0.58±0.04	0.52±0.04	0.51±0.04		0.48±0.03	0.46±0.04	0.51±0.05
11. Infrastructural potential	0.56±0.04	0.60±0.04	0.56±0.04	0.55±0.05	0.67±0.03	0.58±0.04	0.63±0.03	0.59±0.03	0.57±0.04	0.48±0.03		0.47±0.05	0.57±0.04
12. Agribusiness potential	0.53±0.04	0.56±0.04	0.58±0.04	0.59±0.04	0.56±0.04	0.55±0.05	0.57±0.06	0.54±0.04	0.54±0.04	0.46±0.04	0.47±0.05		0.54±0.05
Mean value	0.55±0.05	0.56±0.04	0.53±0.04	0.57±0.04	0.59±0.04	0.55±0.05	0.56±0.05	0.56±0.04	0.56±0.05	0.51±0.05	0.57±0.04	0.54±0.05	

which cost dozens of millions but there is no qualified personnel to maintain this expensive equipment.

Innovation potential becomes a loss, since there in no useful effect from it. Moreover, it is getting morally obsolete; costs do not pay off with health, services etc. Due to irrational use of innovation capital, such potentials as economic, social and financial start shrinking.

4. Analyzing the industrial potential as a goal-setting one and consumer potential as a goal-reaching one it can be concluded that industrial potential provides consumer potential by 30%.

Thus, as a matter of regional policy one can assume that industrial potential focuses on manufacturing needs rather than on the needs of population which were satisfied until recently at the expense of imports mostly.

5. When reviewing the projected connectivity of potentials in 5 years time it can be assumed that, due to modernization of regional policy, innovation potential can provide the growth of labor potential by 70%. The projected evaluation shows the need for a considerable increase of the connectivity coefficient of goal-reaching potentials in providing goal-setting potentials, which should make regional policy ensure the development of region's competitiveness.

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