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ARTICLES dealing with aspects of the interaction between academy-industry-government (Triple Helix) for fostering research, innovation, economic competitiveness and growth. Contributions should be in MSWord, 2500-3000 words, and include a photograph of the author. Contact: devrimgoktepe@gmail.com and sheila.forbes@strath.ac.uk.

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Deadlines for submissions to be included in the related quarterly issue: **24th August 2015** for September 2015 issue; **23th November 2015** for December 2015 issue; **22 February 2016** for March 2016 issue., and **28 May 2016** for June 2016 issue.

METHOD OF ASSESSMENT OF THE LEVEL OF CONTRIBUTION OF TRIPLE HELIX PARTICIPANTS IN THE INNOVATIVE DEVELOPMENT OF THE ECONOMY

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ABSTRACT

This article offers the econometric model of volumetric space of innovation, which describes relationships of the triad (government, business and science/education) in the innovative process. The model is developed on the basis of the "Triple Helix" model, and allows the use of the econometric modeling method, the most convenient and modern tool for numerical calculations applied to forecasting. In this model, the participant 'science/education' appears as a generator of knowledge and innovative ideas, the intellectual property owner in commercialization of which both the authority (government support - is policy), and business (receiving profit - is a market) are interested and take an active part.

As approbation of the method, the result of numerical calculations on the express-assessment of the triad contribution to innovative development of the Far East federal district, on the basis of statistical data for year 2012, are presented. It has been shown that the overall innovation development level of the region's economy in the considered district is generally defined by the innovative activity of the science and education sphere.

The proposed method and the result of the econometric calculations may be useful to government authorities, business structures, and scientific and educational organizations, for adoption of administrative decisions on innovative economic development at different levels.

BRIEF PRESENTATION OF THE STATE-OF-THE-ART

The transition from a national economy to an innovation-based development determines the necessity of innovative potential assessment for units of different levels (country, region, municipality, organization, etc). From an assessment of the innovative process and its potential condition, depend the selection and realization of the innovation strategy of the regional economy development, its industries, and enterprises.

In modern economic literature, various methods and models for assessing the level of Innovation Development of the Region (IDR) are offered. For example, the Institute of Innovative Economy of the Financial University under the Government of the Russian Federation develops conceptions of the formation of the IDR index of Russia. The index represents a complex assessment of IDR for the determination of the potential of the most directions for the investment of the government and business resources, and determination of the efficacy of the state innovative policy in subjects of the Russian Federation (www.fa.ru).

In my opinion, the lack of unified methodological development for choosing indicators characterizing innovative potential is the main reason for the existence of a variety of methods. The econometric calculations of the estimate of innovative potential of the region are made on the basis of the results of the expert opinion polls or weight coefficients, which introduce subjectivity in indicators affecting inaccuracy in assessment results (Bortnik et al, 2012, 2014). Usually, most of these methods estimate rating tables among the regions, such as the level of innovative development of the Russian regions calculated by the rating agency "ExpertRA", or the level of the innovation index in the research of the Independent Institute of Social Policy. At the same time it is impossible to compare the methods of rating agencies on a content level, because the range of indicators monitored by agencies, as well as indicators assigned by experts, are still closed to the general public.

A comparative analysis of innovative activity of territorial subjects of the Russian Federation, on the basis of official statistical data for year 2008, on one indicator - gross regional product - was carried out by V Kiselev (2010). In that paper, the author points to the urgent necessity of improving statistics about innovative activity, and to bring the Russian conceptual framework in the field of innovations to European standards. Golova also noted the necessity of essential system modernization of the state monitoring in the field of science and innovations (Golova 2013). The author considers that a significant imperfection of the offered methods on comparative assessment of the Russian Federation regions by the level of innovative development, is due to the weak linkage with modern problems of innovative and technological development in Russia, and the lack of a clear idea about the usage of the results in practice.

Currently, in foreign and domestic economic literature, there are no data about the methods of the quantitative assessment of the contribution level of science/education, business, and authority to innovative process. It should be noted that existing methodologies are applied generally to the expert assessment of the state of the region economy without sufficient regard of climatic, geographic, economic, and social features of the Russian North. The results of the assessment should depend on the structure of the main economic indicators, which are various for different subjects of Russia. For instance, the main features of the northern regions include extreme climatic conditions, remoteness from the political center, and an insufficiently developed system of transport infrastructure, which cause the high cost of production and the life-support of the population in comparison with the central regions, and the ecological sensitivity of the North.

Therefore, I propose an econometric model of volumetric space of innovations, which was developed on the basis of the 'Triple Helix' model, and allows implementing numerical calculations on the quantitative assessment of the triad participants' contribution to innovative development of the regional economy.

Triple Helix Model

The practice of creating clusters in foreign countries shows that the formation of innovation clusters is not only through market forces, but also the success of their development in one way or another are connected with the so-called 'Triple Helix' mechanism. The Triple Helix model is the secret of success and "formed spontaneously" of Silicon Valley. Although Porter's cluster theory and the idea of the Triple Helix model by Etzkowitz-Leydesdorff were formed independently from each other, they were extremely complementary. Their scientific synthesis shows the unique effect of innovativeness that is achieved in clusters which is determined by their network institutional design, and the economy transition to innovative growth determined by the prosperity of its extensive clustering. Thus, Porter's model traces the mechanism of such growth 'at the output' (as a result of cluster presence), and the helical model 'at the input' (as a condition for their appearance) (Smorodinskaya, 2011).

The Triple Helix symbolizes an alliance between government, business, and university (actors), which are key elements of the innovative system of any country. In particular, where these elements partly overlap, people are meeting and new ideas generated: so the innovation occurs. At the same time, such a model becomes balanced, in which institutional spheres besides performing traditional functions, get additional functions from other institutional spheres.

According to Porter's competitive advantage theory and Etzkowitz Triple Helix model, in the field of cross coverage of the specified actors occur concentration and the most effective use of participants' resources of the innovation process, which gives a synergetic effect for receiving new 'breakthrough' technologies (Etzkowitz 2010; Porter 2005).

In Russia, the Triple Helix still remains at an early stage of formation. It's not yet a system, but principally only paired relationships: science-business, government-science, and government-business. It is characterized by the following features.

Supremacy of government over science and business. Excessive government intervention has a destructive effect on the development of network interactions the emergence of new initiatives 'from below', and their natural distribution.

A major part of the scientific fundamental research occurs not in universities (higher education institutions), as in many countries around the world, but only in institutes of the Russian Academy of Sciences (Dezhina 2011; Dezhina 2008).

The basic principle of the Triple Helix model is to consider the university as a key object. This model assumes the creation of universities of a new type, playing an active role in society, which changes the key functions that are responsible for innovation. In modern Russian conditions, the interaction model of universities, business, and government, can be realized in a limited number of regions in the form of innovative clusters based on technical and natural-science universities, and academic and sectoral scientific centers, in direct cooperation with the federal and regional authorities in realization of national economic development strategy (Monastyrny and Uvarov 2011).

Model of Volumetric Space of Innovations

The formation of the efficiently functioning innovation system is possible when reaching a simultaneous pair of harmonic mutual relationships between science-business, government-science, and government-business, consequently appearing as a special environment - ***volumetric space of innovations (VSI)***, contributing to the creation and diffusion of innovation (Egorov 2013, 2014). Ideally, it takes the form of a cubic volume, but in terms of economy development it depends on the level of the partnership between government, business, and science/education, and the volumetric space of innovation can take different forms of a rectangular parallelepiped (Figure 1). The proposed VSI model is developed on the basis of the Triple Helix model, and allows using an econometric simulation method which is the most convenient modern tool for numerical calculations applied to prediction. In this model, the participant **science/education** appears as a generator of knowledge and innovation ideas, the intellectual property owner, in commercialization of which both the **authority** (government support - is policy), and the **business** (receiving profit - is a market), are interested and take an active part. The formation of such an environment requires systematic work on the stable functioning of the innovative system of the region through effective partner interaction of the main participants in the innovative process to create new directions of business. It is noted that a similar model as a vector representation of the university-industry-government relationships (university-industry-government relations) is discussed by Ivanova and Leydesdorff (2014).

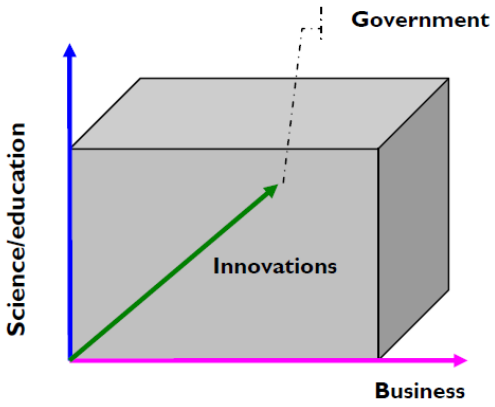

Figure 1
Econometric model of volumetric space of innovations

Research Focus

The econometric model, on the basis of the known trigonometric expression, allows esteeming in a quantitative contribution sense of each of the triad in the innovative development of different economic units. For carrying out the quantitative assessment of university and business contribution in the innovative process, it is sufficient to use the federal and regional official statistics data in the field of innovation.

Efforts of the regional and municipal authorities to create and stimulate sufficient conditions in the region to develop innovative activities, generally are defined by the existence of legislative and a normative basis and regional programs (projects) in the field of innovation, and by the level of innovative infrastructure development. Therefore, these indicators should be taken into account when carrying out quantitative assessments of innovative development. For example, as an indicator of elaboration of the legislative base, it is possible to take the specific weight of normative legal acts regulating innovative activities and in total quantity of adopted legislative acts in the field of socio-economic development of the region. For instance, the level of elaboration the normative legal acts of the Russian Federation is 0.66 points, and for the Siberian federal district is 0.33 points (the specific weight of each unit to the maximum, proceeding from the existence of acts) (Vladimirova, 2012). Similarly, we can estimate the rate of government assistance to the innovative process through the adoption of regional innovation programs, projects, and forming the innovative infrastructure.

Thus, carrying out an economic-mathematical simulation on the basis of the VSI model allows evaluating the innovative activity of Triple Helix participants in the economic development of the whole region and separate municipality, the real sector of economy, territorial innovation clusters, etc.

According to the model of volumetric space of innovation, the total resulting index value of innovation region's development can be calculated by using a known mathematical formula for determining the radius vector of a rectangular parallelepiped:

$$I = \sqrt{I_1^2 + I_2^2 + I_3^2} \qquad (1)$$

where I_1, I_2, *and* I_3 are integral indexes of the main participants of the innovative process (science/education, business and authority).

All internal estimated indexes of each integral component are normalized (are resulted in the relative value) using the formula below that determines a unified scale of measurement of all calculated coefficients K_{ij} (i is the component number, *j* is the number of the internal target of the *i*-th group):

$$K_{ij} = \frac{x_{ij} - x_{ij}^{\min}}{x_{ij}^{\max} - x_{ij}^{\min}} \qquad (2)$$

Thus, each component I_j ($I = 1, 2, \ldots, m$) will consist of several coefficients, with values ranging from 0 to 1. The average value for the group of indexes of the relative values, as we know, is found from a statistics course, as an average geometrical value:

$$I_i = \sqrt[m]{k_{i1} \times k_{i2} \times \ldots \times k_{im}} \qquad (3)$$

The contribution of *nth* participant of the innovation process to the overall innovation region's development is determined in percentage by the following formula:

$$K_n = I_n / I * 100\% \qquad (4)$$

The total index value of the innovation region's development level is defined as a sum of the contributions of each participant of innovative process:

$$K_1 + K_2 + K_3 = 100\% \qquad (5)$$

According to Kazantsev, in researching with a definite purpose of the specific object should not excessively expand a set of its studied features and maximize accuracy of their quantitative representation. It is possible to select research tools, which are adequate to the nature and accuracy of the analyzed characteristics of the examined object, instead of the famous and powerful from those available. Even with simple tools and limited information, it is possible to receive informative results, which are useful for working out elements of economic policy (Kazansev, 2012). Based on this approach, to carry out the express-assessment of the region's innovative activity, it is possible to use a simplified system of the main indexes, characterizing the contribution of science/ education, business, and government, in the overall innovation development of the region.

In Table 1 the list of main indicators is presented, which the author considers sufficient for carrying out the express-evaluation of the level of activity of participants of the Triple Helix.

Findings and Interpretation

All calculations were carried out on the basis of official data from the Federal State Statistics Service (Rosstat) for the year 2012, with the reference portal "Science and Innovations in Regions of Russia". Figure 2 shows the distribution of activity for the main subjects of innovation in the regions of FEFD.

As can be seen, the leading place among the regions is Primorsky Krai, basically owing to the quantity of received intellectual property objects (IPOs) (268 units), and the number of personnel occupied with research and development (5482 people). The same indexes are rather high for Khabarovsk Krai (236 units of IPOs; 1612 people), and the Republic of Sakha (Yakutia) (90 units of IPOs; 2378 people).

Table 1
The system of indexes for the express-assessment of innovative development of the regions of the Far Eastern Federal District (FEFD)

Triple Helix Participants	Index name*
Science/education (knowledge) *(I_1)*	Share of organizations realizing research and development
	Share of personnel occupied with researches and development
	Share of intellectual property objects
Business (market) *(I_2)*	Level of innovation activity organizations
	Expense ratio on technological innovations
	Specific weight of volume of innovative products, works, services in the total volume of shipped goods, performed works, services
Government (policy) *(I_3)*	Share of legislative and normative legal acts in innovation policy
	Share in quantity of organizations of innovative infrastructure
	Expense ratio on research and development

**All indexes are given percentage wise to the corresponding total indexes for the FEFD*

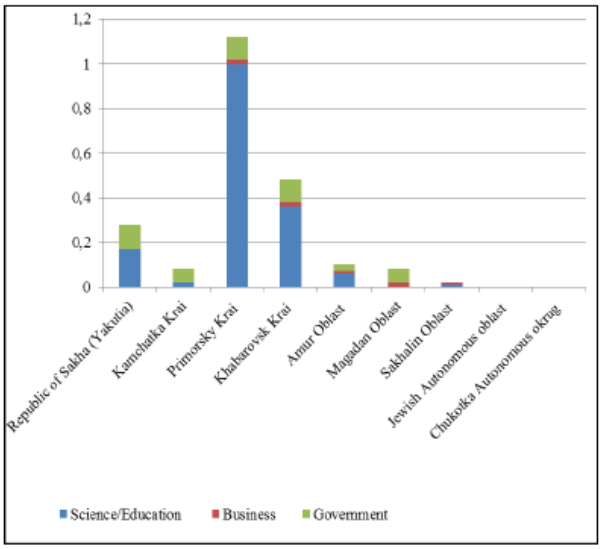

Figure 2: Activity level of main subjects of innovation in regions of FEFD

The calculation results show that a significant contribution to the innovative development of the regions of FEFD is made by science/ education (75.7%), while the levels of activity of business structures and public authorities are only 6.5% and 17.8%, respectively (Figure 3). This result indicates insufficient involvement and the use of results of intellectual work of universities and research institutions in the development of innovative activity of the region. The participation of the public authority in the innovative development of the regional economy is mainly determined by the presence of the legal basis in the sphere of innovative activity and the size of expenditure on scientific research and development. But these indexes do not have a significant impact on the real state of innovation in the regions.

It is noted that in the general innovative development of the economy of FEFD the greatest contribution (76.6%) is made by subjects of the southern zone of the macro-region (Primorsky Krai, Khabarovsk Krai, Amur Oblast, Sakhalin Oblast, and the Jewish Autonomous Oblast), having high scientific and educational potential (66.2%). The share of contribution of four regions of the northern zone (the Republic of Sakha (Yakutia), Kamchatka Krai, Magadan Oblast and Chukotka) is only 8.8%.

Thus, to carry out economic-mathematical calculations about assessment and monitoring of the innovative activity of the Triple Helix participants on the basis of volumetric space of innovations, it is necessary to make an appropriate system of indexes characterizing the innovative potential of university and business, and the innovative policy of government.

Conclusions

To conduct economic and mathematical calculations of assessment and the monitoring of innovative activity of economic subjects

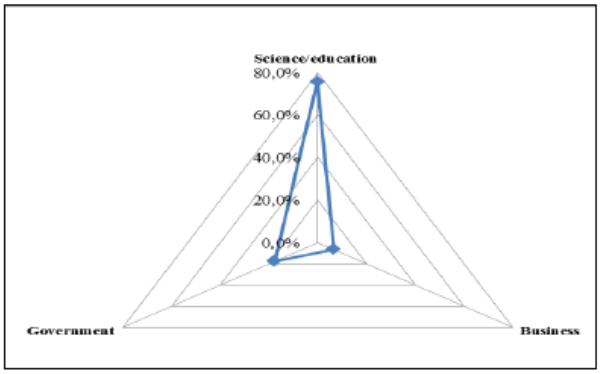

Figure 3: Distribution of contribution of participants of Triple Helix in innovation development of regions of FEFD

according to the method used, it is necessary to make an appropriate system of indicators, which characterize the innovative potential of universities and business, as well as the state innovation policy.

The realization of numerical calculations by the method offered, basically allows evaluating the role of each triad participant in innovation development of a whole region and in the context of separate municipalities, branches of the real economy sector, territorial innovation clusters, etc. The calculation results will depend on the choice of accepted economic indexes of the researched object.

Policy implications

Calculation results may be useful to executive bodies of the government, business structures, and scientific and educational organizations, for analyzing and forecasting formation and development of innovative systems, strategies, and economic development programs at various levels.

Direction for Further Research

The direction for further research on the basis of the VSI model are connected with the resolution of issues of the impact assessment of innovations in the social sphere, which include the study of influence of processes of innovative activities on social indicators of human activity.

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