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Estimation of Innovative Activity of the University

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Abstract: Higher education institutions act as one of the most important factors for the development of region. Russian traditional educational institutions should be transformed to meet the challenges of modern world. On the basis of Belgorod region innovation activity analysis, positive relationship between shipped innovation items and domestic research and development costs was found. Semantic differential was used for multiple estimation of BelSU innovation activity and competiveness. BelSU integrated index showed high-enough innovation activity of this university.

Key words: Innovations, inventive activity, higher education institutions, patent, semantic differential, Belgorod region

INTRODUCTION

Pursuing sustainable market position, modern higher educational institutions become members of complex innovation systems. In response to the growing needs of high-tech businesses, universities create innovative business environment that is able to provide high productivity of the region and lead to a significant structural changes.

Modernization of higher education in Russia involves transformation of traditional higher education institutions to another institutional form: entrepreneurial, innovative, research.

However, practice shows that this transformation meets numerous difficulties which have environment nature and country specifics of higher education in Russia. Foreign models of higher education institutions which are successful in other countries are not competitive in Russian reality. For the purpose of solving this scientific issue, conceptual model of innovative university, which combines achievements of traditional higher education, modern requirements and criteria of the knowledge economy is required.

Interest of scientists in universities functioning particularities as factor of economic competitiveness is currently rising. However, not all aspects of determined issue received adequate attention. Items considered in this research require specific solutions which take into consideration multilevel professional training and research and scientific activity of university students and participants. Most of papers considered this issue are written by Foreign scientists but Russian scientists and public figures are also dedicated to aspects of transformation of traditional higher education institutions to another institutional form. Basis of the modern type universities formation, their strategic development and management, as well as results of innovation activity of higher education institutions in the real economy transfer are in focus of following researchers: Lomovtseva (2013), Lomovtseva and Kochetkov (2010), Stevenson (1983), Ovsyannikova (2005), Baranova and Fadeykina (2015), Kamarulzaman *et al.* (2013), Tanha *et al.* (2011), Osgood *et al.* (1957), Osgood (1956) and Shin *et al.* (2012).

MATERIALS AND METHODS

The study started with literature review and statistical data that provides the background for estimation of innovation activity of higher educational institutions in Belgorod region. The dynamics of main statistical indicators (time series data) characterizing innovation activity of Belgorod region in general was analyzed by economic and mathematical methods and statistical methods. R^2 was used to measure of how close the data are to the fitted trend line. Exponential smoothing was used to smooth out irregularities caused by so-called atypical events.

Following methods were used to solve considered issues: analysis and synthesis, grouping and classification, system analysis, hierarchy analysis, monographic analysis, expert evaluation, induction and deduction, questionnaires, rating and ranking, logical comparison, theoretical generalization, scientific observation, economic and mathematical methods and statistical methods.

To estimate an innovation activity of higher educational institutions following structural-logic scheme is proposed (Fig. 1).

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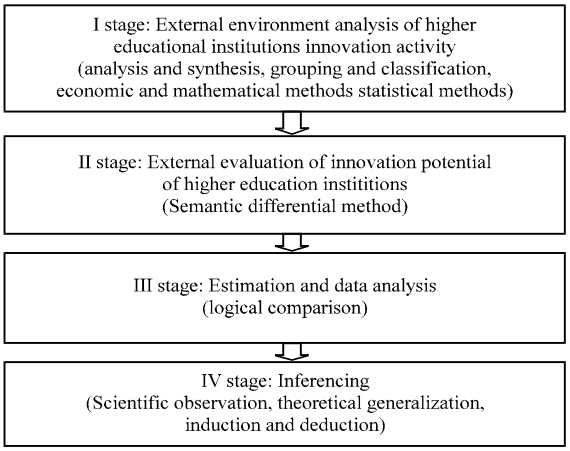

Fig. 1: Structural-logic scheme of higher educational institutions innovation activity

RESULTS AND DISCUSSION

To characterize innovation activity of higher educational institutions dynamics of innovation activity of Belgorod region was analyzed as primary data.

Inventive activity level and patenting of inventions recognizes innovation and scientific and technological potential of region. Figure 2 displays the dynamics of amount patent applications increment from 2006-2013, (2006 comparable level) in absolute terms and per 10,000 inhabitants of Belgorod region.

In 2011 and 2013, the amount of applications per 10 000 inhabitants of region pierces the level of 2006. Total amount of invention patent applications from Belgorod region applicants per year in period from 2007-2013 not once increased the level of 2006. Consequently, the inventive activity per inhabitant grows faster than in absolute figures.

Reliability of trend line that describes the number of applications from Belgorod region is 0.79 (Fig. 3). In 2010, this trend line attained a minimum and at the time of writing tends to increase.

As seen from analysis of research and development organizations in Belgorod region in period from 2006-2013 their amount decreases (over the period under review it declined by 28.5%), the number of higher educational institutions that had a research and development activity also reduced (by 25%) (Fig. 4).

Analysis the research and development personnel structure revealed that the total amount of personnel reduces (by 4.4% in period from 2006-2013), however, analysis the structure of research and development personnel revealed that share of researchers in personnel tends to grow and in researched period increased from 54.1-70.3% (Fig. 5).

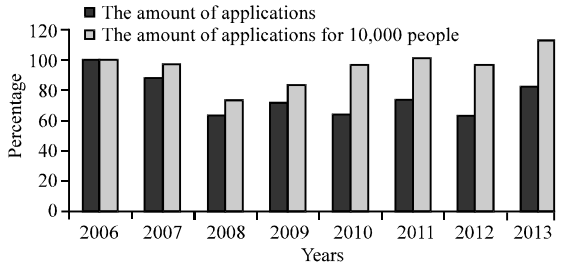

Fig. 2: The amount of invention patent applications from Belgorod region applicants per year in period from 2006-2013

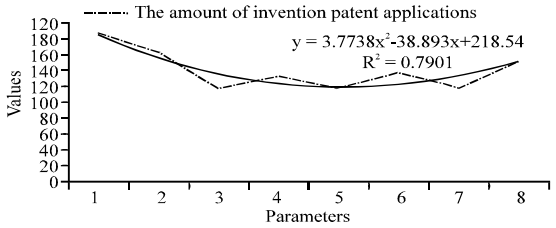

Fig. 3: The amount of invention patent applications from Belgorod region applicants in period from 2006-2013

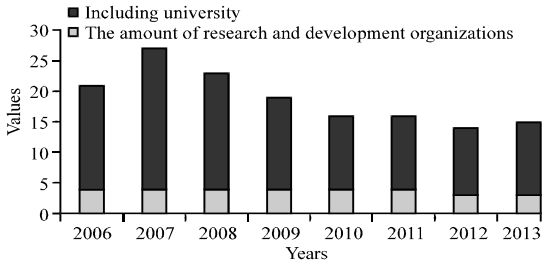

Fig. 4: The amount of research and development organizations in Belgorod region from 2006-2013

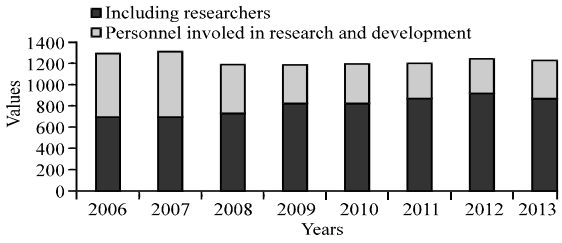

Fig. 5: Structure of research and development personnel from 2006-2013

Belgorod region innovation costs dynamics can be described by a linear trend line ($R^2 = 0.93$). Linear trend is increasing, it indicates the increase the domestic innovation costs in Belgorod region in future (Fig. 6).

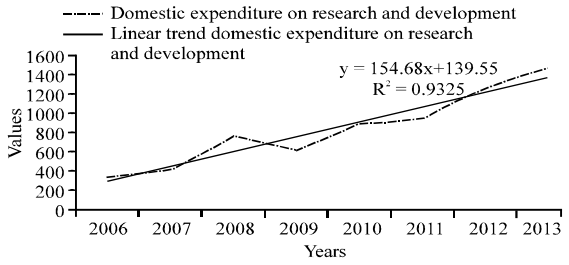

Fig. 6: Domestic innovation costs in Belgorod region from 2006-2013

The figure shows the volume of shipped innovative goods, works and services. Demand for goods, works and services is affected by so-called atypical events that is why for data dynamics analysis and forecasting the influence of these factors was neutralized by exponential smoothing method.

To smooth out irregularities caused by so-called atypical events exponential smoothing was used. The smoothing scheme starts with setting St (smoothed observation) to y_t (original observation). Subscript refers to time period. Smoothed observation for period is:

$$St = \alpha yt - 1 + (1 - \alpha)\ St - 10 < \alpha \leq 1t \leq 3 \qquad (1)$$

Where, α the smoothing constant. The results of a series of exponential smoothing "Volume of shipped innovative goods, works and services" if $\alpha = 0.4$ are shown in Table 1 and Fig. 7.

Quantitative estimation of relationship between internal research and development costs and volume of shipped innovative goods, works and services (smoothed data) in Belgorod region was calculated by correlation coefficient. For researched period (2006-2013) correlation coefficient is 0.69 which indicates the positive relationship between the studied variables.

To evaluate innovative activity of university is reasonable to apply semantic differential method. This method was developed by American psychologist C. Osgood in 1952 for semantic spaces (Osgood *et al*., 1957; Osgood, 1956) (individual and group). However this method could be applied not only as experimental psychology methods.

Principle of method consists in selection of several characteristics of item. It could be done for innovative activity of higher educational institution estimation,as component of its competitiveness.

Semantic space coordinates are rate scales. On opposite poles of the coordinate system are opposite criteria. This method is useful for estimation of innovative

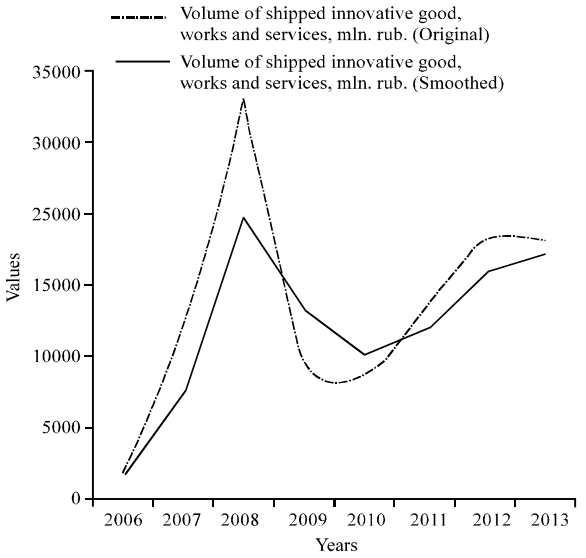

Fig. 7: Volume of shipped innovative goods, works and services from 2006-2013 (actual and smoothed data)

Table 1: Volume of shipped innovative goods, works and services in Belgorod region from 2006-2013 (original and smoothed observations)

	Volume of shipped innovative goods, works and services, mln. rub.	
Years	Original	Smoothed
2006	2052.7	2052.70
2007	13377.9	8847.82
2008	32978.9	23326.47
2009	10437.5	15593.09
2010	9391.6	11872.19
2011	15457.4	14023.32
2012	21683.4	18619.37
2013	21246.5	20195.65

activity of university in all and provides the estimation by several criteria simultaneously. The result is "Graphic profile innovation activity of university".

As in Osgood (1956, 1957)'s Method, here three basic 1-7 rating scales (Table 2). Next stage of estimation of innovation activity of university by semantic differential method is expert evaluation of university activity. Employees of BelSU was taken as experts. For these purposes they evaluate BelSU on rating scales from Table 2. On analytical stage of collected data proceeding, the average estimations of innovation activity by evaluated criteria were received. It is essential to take into consideration significance level of each criterion to get more reliable estimation.

University innovation activity development coefficient (K_{inn}) calculated by Eq. 2:

Table 2: Estimation innovation activity of university rating scale (by semantic differential method)

		University rating		
Semantic descripiion	Parameters	Increasing	Decresing	Variables
Inventive activity and innovation patenting level	High	3, 2, 1, 0	1, 2, 3	Far behind the necessary level
Researchers share in personnel structure	High	-	1, 2, 3	Low
Existing strategy of university development	Efficient (results to competitiveness level growth)	-	1, 2, 3	Inefficient (changes required)

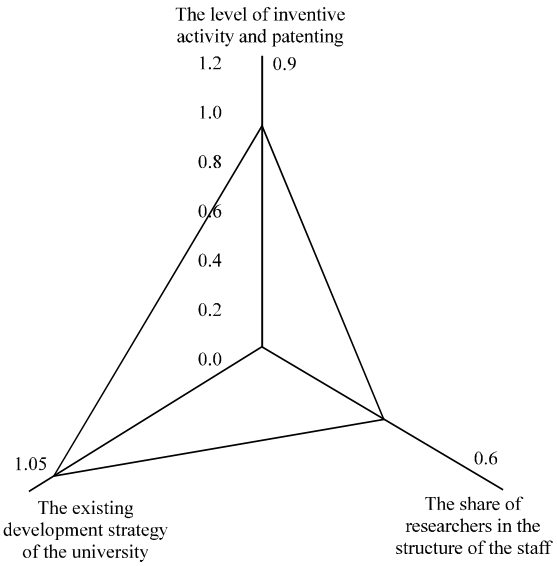

Fig. 8: The results of university innovation activity estimation calculated by semantic differential method (for BelSU)

$$K_{inn} = \frac{\sum B_i \times K_i}{\sum K_i} \quad (1)$$

Where:

B_i = Criterion estimation by rating scale

K_i = Significance level of criterion

Based on expert evaluations following significance levels were determined: inventive activity and innovation patenting level (0.45); researchers share in personnel structure (0.2); existing strategy of university development (0.35).

To achieve the high level of innovation development and ability of university to become a regional growth point, inventive and invention patenting activity level is the main competitive advantage and significant criteria in innovation activity evaluation by semantic differential method.

Proposed methodological approach was used to calculate the index of innovative activity development. Visualization of the result is shown in Fig. 8. Index of university innovation activity development:

$$K_{inn} = \frac{0.9 + 0.6 + 1.05}{0.45 + 0.2 + 0.35} = 2.55$$

it is high enough. With this method we can evaluate and rank the university in terms of development of innovative activity. It is characteristic for the method of semantic differential to have of many advantages: it has high visibility; you can quickly identify ways to improve the innovative capacity and to calculate the final grade. The main problem of using the semantic differential method concerning of selection of parameters and their importance and quality selection of experts.

CONCLUSION

The results of analysis of innovative activity in the region indicates that universities must perform in addition to the traditional functions and created a transfer of knowledge in the production and commercialization of intellectual property. The estimation of innovative university will contribute to the creation of such structures in the Russian Federation as well as the speedy transformation of traditional universities in entrepreneurship and innovation with achievements of traditional and modern requirements for the educational activity.

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