The Knowledge Economy as Regional Strategy: Evidence From Russia

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Abstract: This paper treats the issues of regional growth based on the achievements of the knowledge economy. Having arisen in the 1960s, the theoretical framework of the knowledge economy initially spread in the corporate sector. Already by the end of the 20th century, it had begun to be actively applied on a macro level. The main objective of this research is to identify factors influencing the success of regional economic growth based on achievements in the knowledge economy. Research was conducted using statistical data obtained from the Russian Federation. Firstly, an econometric study of the impact of the knowledge economy development indicators on GRP was conducted. The correlation analysis of the study has shown an interrelation of economic development and education indicators, in particular, the quantity of faculty output in the region. Additionally, a multiregression analysis was conducted by means of the Stepwise technique. Initial data were transformed according to several means of (Box-Cox transformations, logarithm) for determining nonlinear dependencies. The results have revealed key factors of the knowledge economy influencing the GRP indicator. The regression analysis was also used to provide weighting coefficients, which influence dependent variable (GRP) based on the constructed knowledge economy composite index of the Russian regions. The leading and lagging groups of regions were determined using knowledge economy indicators on the basis of the final index values. The results were analysed through the application of statistical techniques. A comparison of these two groups of regions revealed the key institutional factors influencing the development of entrepreneurship in regions and the construction of the new economy as a whole. These "best practices" can be transferred to regions either in Russia or other countries with a transition economy. The results of the study can be applied to further theoretical and applied regional studies, as well as for indicative planning and the formation of regional economic policy.

Keywords: regional development, knowledge economy, institutional modelling

1. Introduction

The knowledge economy has its origins in the work of Joseph Schumpeter (Schumpeter, 1934), who formulated the concept of economic growth based on the diffusion of innovation. According to Schumpeter, any innovation goes through three stages in its development, i.e. invention, innovation (implementation of the invention by an entrepreneur) and imitation (copying of innovation by other market players). Many of the terms coined by Schumpeter, are relevant in the present day, e.g., entrepreneurial profit and creative destruction.

Mankind entered a new stage in its development in the 1960s, as evidenced by wide spread of automation and the massive introduction of scientific inventions. This process was studied by globally recognised sociologists Alvin Toffler, Daniel Bell and Pitirim Sorokin (Bell, 1973; Sorokin, 1964; Toffler, 1980). They formed the concept of the post-industrial society based on the free access to knowledge (research, first of all) and scientific and technical progress (STP). This concept gave rise to the widely used term "information society", and it must be pointed out, "information" and "knowledge" are often used as synonyms. The Austrian and American economist Fritz Machlup conducted influential research on the classification of knowledge (Machlup, 1962), classifying knowledge due to its application to areas of economic activities. D. Stigler considered knowledge as an economic category with an emphasis on information search costs (Stigler, 1961). It was Peter Drucker, however, who disclosed the role of knowledge in the creation of added value in the 1970s (Drucker, 1977). Drucker emphasized the significance of knowledge as the main economic resource of the new society.

The Lisbon Strategy of the European Union ("Lisbon European Council 23 and 24 March Presidency Conclusion", 2000) stated these theses. Many researchers believe the knowledge economy and knowledge-based society to be the most important (if not the only) way to solve social, economic, technological and political challenges facing society (Melnikas, 2011). The author also makes an important assumption about the role of knowledge as the main factor of economic growth within the context of the knowledge economy; concurrently, knowledge is a core value of the knowledge-based society and a determinant of social evolution.

Much has been said about innovation, the knowledge economy, technological modernisation and the diversification of the economy (Gluhov, 2003; Higher School of Economics, 2008; Makarov, 2003) in Russia over the course of the past 15 years. However, despite the fact that regional knowledge clusters form essential "building blocks" for the knowledge economy and knowledge-based society at national and global levels, very little attention has been paid to the modelling of knowledge generation at a regional level. In particular, A.A. Tatuyev wrote about the transformation of regional economies based on the theoretical framework of the knowledge economy (Tatuyev, 2010). I.I. Kuyantseva and M.I. Kuyantseva used the methods of index construction in the field of the intellectual capital and knowledge economy to evaluate the dynamics of the innovative development of the Rostov region (Kuyantseva & Kuyantseva, 2011). Yet the majority of rankings and assessment methodologies consider the level of innovation and technology development in the region, whereas this is only a component of the knowledge economy. The primary purpose of our study is a ranking of the Russian regions in terms of the knowledge economy development utilising the original technique. Analysis of the ranking results will enable further institutional analysis of regional policies and practices.

2. The knowledge economy index of the region

At the global level, two international organisations conduct the analysis of the knowledge economy indicators. These are the Organisation for Economic Cooperation and Development (OECD) and the World Bank (WB). The OECD proposed a methodology ("The Knowledge-based Economy", 1996), which includes more than 200 indicators in four areas: information society, globalisation of the economy, productivity and financial structure. In turn, the methodology of the World Bank ("Knowledge Assessment Methodology", 2012) includes 148 indicators for 148 countries in the following areas: economic performance, institutional regime, power, innovation, education, gender indicators and information and communications technology (ICT). The KAM Knowledge Index (KI) and The Knowledge Economy Index (KEI) have been created on the basis of these techniques ("KI and KEI Indexes", 2012). Also, an attempt was made to create a unified index based on fuzzy clustering model (Shami et al., 2011), which would be able to predict values for the emerging economies, where not all the data are available.

These techniques have been engineered to analyse the level of development of the knowledge economy at the national level. Despite the fact that Russian statistics are still quite limited, we believe that their partial use, after appropriate adaptation, is applicable for the purposes of this study. A similar study was conducted in Ukraine (Tyshchenko, 2013); it was grounded on the indicators of innovation, education and ICT. It should be noted that the purpose of the study was also the grouping of regions in terms of the knowledge economy development and allocation of the problem regions. Some researchers also used to analyze the indicators of overall performance of the economy and cultural capital (Affortunato et al., 2010). However, in our view, this approach leads to an erosion of research results; besides, the quantitative economic indicators of the region or country are likely to be the outputs of model, and mixing them with the inputs seems impractical.

3. Methodology

Based on the above-mentioned methods of the international indexes, data was selected from statistics available in Russia. The indicator of investment into fixed assets was also included; this was because, in our opinion, it best indicates the quantitative aspect of modernisation in transition economies. The diverse statistical population was formed on the basis of data from the Russian Federal State Statistics Service as follows:

A. Innovation and technology level
(1) Labour productivity index;
(2) Share of high-tech and knowledge-intensive industries in GRP;
(3) Innovative activity of organisations (the ratio of organisations implementing technological, organisational and marketing innovations to the total number of organisations);
(4) Share of innovative products, works and services in the total volume of shipped goods, works and services;
(5) Advanced manufacturing technologies used;
(6) Current domestic expenditures on research and development;
(7) Expenditures on technological innovations of organisations;
(8) Investments in fixed assets per capita;
B. Science and education development level
(9) Ratio of inventive activity (the number of domestic patent applications for inventions filed in Russia, per 10 thousand people of the population);

(10) Number of employees engaged in research and development;
(11) Number of graduate students in the regions of the Russian Federation;
(12) Number of doctoral students in the regions of the Russian Federation;
(13) Number of educational institutions of higher education;
(14) Number of students enrolled in undergraduate, graduate and master's programmes;
(15) Number of faculties of higher education institutions;
C. Use of information and communication technologies (ICT):
(16) Proportion of organisations using a personal computer;
(17) Proportion of organisations using the Internet;
(18) Proportion of organisations with a website;
D. Institutional regime
(19) Ranking of regional democratisation.

These 19 variables and indicators are model inputs characterising the level of development of the knowledge economy in the region. We chose Gross Regional Product (GRP) as an output or resultant variable, since it is the most objective indicator of economic development. In the case of variables (12) (13) (14) (15), data was only available for the year 2012. Data for variable (19) – ranking of regional democratisation – was calculated in 2010. All other variables used data relating to the year 2014. However, we consider it permissible to use this data for analysis because institutional factors and indicators of education affect the economy with a lag of several years.

GRP and variables (5), (6), (7), (9), (10), (11), (12), (13), (14) are absolute; the remaining (except (19), which is a ballpark qualitative assessment) are relative. In order to make them independent of the region's size and diversity of the data, we decided to normalise these figures according to the formula:

$$I = \frac{Vraw - Vmin}{\text{Vmax - Vmin}} \quad (1)$$

where I is the normalised value of the index; Vraw – the current value of the index; Vmin – the minimum value of the range, Vmax – the maximum value of the range.

The next stage of the study was the correlation analysis, the purpose of which was the determination of the potential relationship between the variables and GRP. At the first stage, we found a negative correlation with variables (1) and (2); we also faced intercorrelation between variables (5), (6), (7), (9), (10), (11), (12), (13), (14), (15); (10), (11), (12), (13), (14), (15) and (19), also (16) and (17). As a result, it was decided to leave variables (8) and (18) for further analysis. We gave selection preference to the variables that have a higher correlation coefficient with GRP.

Using the resulting data set, a multiple regression equation by the Stepwise technique was devised. Selection was conducted by the forward method, i.e. gradual addition of indicators testing the coefficient of determination R2. If the index did not increase the value of R2, we exclude it from the regression equation. Also a multiple regression equation in logarithms was devised; it was assumed that the use of logarithms would improve the quality of the model compared to a simple linear relationship. The last stage of the regression analysis was the application of the Box-Cox transformation for the purpose of dependence linearisation.

Further, a final ranking was assigned to Russian regions in terms of the knowledge economy. It was called the Russian Knowledge Economy Index (RKEI). The simple addition of each indicator's value does not add up to the objective composite index, because each of the indicators affects GRP in varying degrees. Accordingly, each of the indicators was assigned a weighting coefficient. Coefficient corollaries of particular indicators were used with GRP as weighting coefficient. For the analysis of the final knowledge economy index, statistical methods to identify leading and backward groups were used. We determined the number of groups according to the Sturgess formula:

$$n = 1 + 3.322 \log N = \log_2 N \quad (2)$$

where n is the number of groups, N – the number of units in the population. In turn, we determined the size of the interval by the formula:

$$i = \frac{(Xmax - Xmin)}{\text{n}} \quad (3)$$

where *i* is the interval size, Xmax – the maximum value of the index, Xmax – the minimum value of the index.

4. Results and discussion

Table 1 represents the correlation coefficients obtained in the first stage of the study.

Table 1: Correlation of the knowledge economy indicators of the region with GRP

#	Indicator	Correlation with GRP
(3)	Innovative activity of organisations (the ratio of organisations implementing technological, organisational and marketing innovations to the total number of organisations)	0.219
(4)	Share of innovative products, works and services in the total volume of shipped goods, works and services	0.134
(6)	Current domestic expenditures on research and development	**0.937**
(8)	Investments in fixed assets per capita	0.063
(9)	Ratio of inventive activity (the number of domestic patent applications for inventions filed in Russia, per 10 thousand people of the population)	**0.700**
(18)	Share of organisations with a web-site	**0.508**

The highest correlation coefficients were found in case of variables (6), (9) and (18).

Multiple regression gave a strong enough coefficient of determination R2 = 0.89. The result of the F-test determining the significance of the equation as a whole is equal to 101.87; this is much larger than the tabulated value of the test (F = 2.23) at a significance level of 0.05. It was not possible to obtain an improved model by applying logarithmic conversion to the raw data – the determination coefficient remained the same. Box-Cox transformation also did not improve the quality of the model.

The collinearity revealed in the first stage analysis suggests the impact of the factors of the second level. This model is graphically represented in Figure 1.

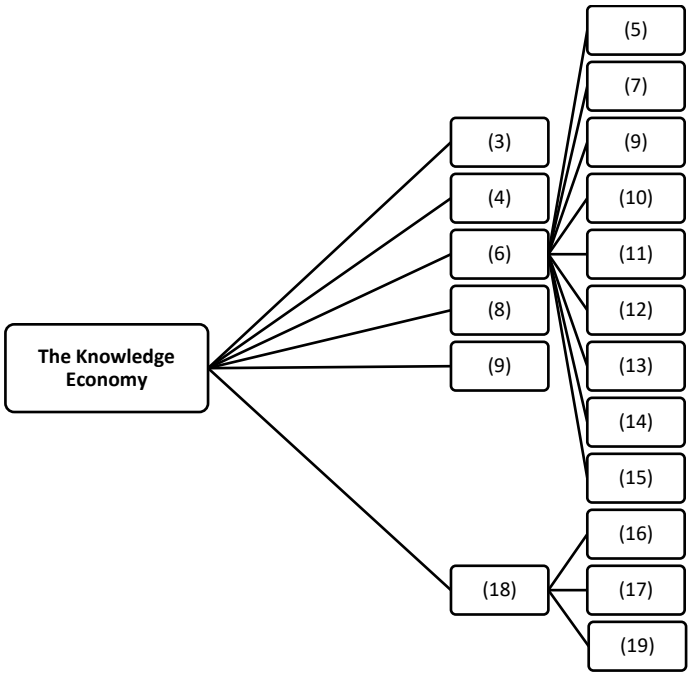

Figure 1: The two-level model of the knowledge economy indicators

After constructing a composite index of the knowledge economy of Russian regions, we distributed them according to the Sturgess formula. The final distribution of regions by groups shows a wide scatter of values at the top of the table and much more uniformity below (Table 2). Thus, 5 Russian regions (out of 83) are significantly distinguished by the level of their knowledge economy development; therefore, we can conclude a very uneven character of regional development.

Table 2: Distribution of regions

Group number	Number of regions	Total value of the knowledge economy index
1	1	2.312
2	1	1.162
3	3	0.790
4	2	0.683
5	11	0.543
6	33	0.406
7	28	0.282
8	4	0.140
Total	**83**	**0.422**

Due to the very large gap in the values we had to make Moscow, Moscow region and St. Petersburg as a separate group. 65 Russian regions are below the median value of the index. Thus, Pareto rule works here very well. Table 3 shows the leading and backward groups of regions in terms of the knowledge economy development. Calculation of individual indicators was conducted with adjustment for the weights.

Table 3: Leading and backward groups of Russian regions in terms of the knowledge economy development

Ranking	Region	Innovative activity of organisations	Share of innovative products, works and services	Current domestic expenditures on research and development	Investments in fixed assets per capita	Ratio of inventive activity	Proportion of organisations with a web-site	Index of the knowledge economy
1	Moscow (federal city)	0.139	0.025	0.937	0.003	0.700	0.508	2.312
2	Saint Petersburg (federal city)	0.140	0.027	0.190	0.002	0.367	0.436	1.162
3	Moscow region	0.062	0.029	0.294	0.002	0.254	0.231	0.872
4	Tomsk region	0.100	0.008	0.053	0.002	0.386	0.202	0.752
5	Republic of Tatarstan	0.152	0.046	0.044	0.004	0.261	0.241	0.748
…								
80	Transbaikal region	0.037	0.016	0.002	0.001	0.041	0.096	0.193
81	Krasnodar region	0.043	0.003	0.024	0.003	0.105	0.010	0.189
82	Tyva Republic	0.010	0.000	0.005	0.001	0.004	0.077	0.097
83	Chechen Republic	0.000	0.004	0.003	0.001	0.023	0.052	0.082

According to the given interval, only the Russian capital Moscow falls into the first group. In our opinion, this is due to the high concentration of intellectual resources; Moscow is practically very much ahead of the closest "competitors" in the number of patents and current expenditures on R & D. The second group also includes only one region – St. Petersburg, the second capital of Russia. St. Petersburg is closer in performance to the Moscow region than to Moscow. Low levels of innovative and patent activity are due to the fact that the resources of

Moscow Region are exploited by Moscow, which is a separate region, and this is the unique specificity of the region. The third group includes Moscow region, Tatarstan, and Tomsk region. Almost all of these regions (except the Tomsk region) are situated in the western part of Russia, which leads to the conclusion about the impact of proximity to the centre of the country on the formation of the knowledge economy. Among the lagging group, we should note Krasnodar region, which has relatively high values of expenditures on research and development and inventive activity; however, this has no impact on other indicators such as innovative activity of organizations and the share of innovative products. Perhaps, this phenomenon can be explained by the inefficient system of knowledge transfer in the region.

Out of the Volga regions, first of all, Tatarstan has been successful in developing both traditional and new industries. The achievements of the Republic of Tatarstan are largely explained by the strategic development of various aspects of the knowledge economy. The share of industrial production in the Republic of Tatarstan is 44.1%; the most developed industries are petrochemical complex, mechanical and electrical engineering and instrumentation. There are several industrial parks in the region, i.e. JSC "Innovative Technopark "Idea", the "Master" industrial area, IT-park, "Himgrad" technopolis, as well as the "Alabuga" special economic zone of industrial-production type (“Jekonomika Respubliki Tatarstan [Tatarstan Economy]”, n.d.). Kazan is also one of the leading centres of information technologies in Russia.

The economy of Tomsk relies both on natural and intellectual resources; however, the sector with the highest share of GRP remains the production of hydrocarbons. In addition, there are developed industries such as transport and communications, trade, agriculture, and construction. In recent years, high-tech industries have been rapidly developing, including nanotechnology, biotechnology and information technology.

Practically every region has at least one strong university participating in the Russian Academic Excellence Project 5-100: the Republic of Tatarstan – Kazan (Volga) Federal University; St. Petersburg – V.I. Ulyanov (Lenin) Saint Petersburg State Electrotechnical University LETI, Saint Petersburg State Polytechnic University (SPbPU), ITMO University and St. Petersburg State University; Moscow – National Research University Higher School of Economics (HSE), the National Research Technological University NUST MISIS, National Research Nuclear University MEPhI, Moscow Institute of Physics and Technology, Sechenov First Moscow State Medical University of Russian Ministry of Health, People's Friendship University of Russia, and Lomonosov Moscow State University. In Tomsk, the project 5-100 includes 2 universities – Tomsk State University and Tomsk Polytechnic University. The latter is one of the leaders in Russia in the field of technology transfer, which is reflected in patent activity, close ties with the business and the organisation of small innovative enterprises.

At the bottom of the table the picture is more homogeneous. As expected, among the outsiders are national republics (the Chechen Republic, the Republic of Tyva) that simultaneously exhibit extremely low levels of knowledge economy and GRP. A significant share in the structure of the consolidated budgets of these regions are occupied by transfers from the federal government (Zubarevich, n.d.). The lack of an industrial base makes them dependent on federal income redistribution; meanwhile, innovative sectors of the economy are also failing to develop. While Chechnya has extensive reserves of oil in its territory, the oil industry does not stimulate the modernisation process in its economy: this is in contrast to the northern regions of Russia. It is surprising to find the Krasnodar region at the end of the table among the lowest in terms of knowledge economy development and GRP. This phenomenon is likely to be explained by a low level of diffusion of innovation in agriculture and tourism industries, which are fundamental for the region.

5. Conclusions

The role of knowledge in the innovative socio-economic development has become absolutely critical: knowledge has become a major factor of economic growth and a key social value. A significant unit of the knowledge economy is comprised by the regional economic system. Russian regions were ranked in terms of their knowledge economy development. As a result, the Russian Knowledge Economy Index (RKEI) was formed. Available statistical indicators of the knowledge economy development were selected with GRP being chosen as the main output of the model or resultant variable.

The study has found correlations between, on the one hand, current expenditures on R&D, inventive activity ratio (the number of patent applications) and the proportion of companies having their own website in the region and, on the other, the volume of GRP. The correlation with other indicators under consideration revealed

second-level factors. The resulting knowledge economy index has empowered analysis of the characteristics of the regions, which are at the top and bottom of the list. The authors identified five of the most promising Russian regions in terms of the knowledge economy.

The regions featured in this list bring together a number of important characteristics:

- Proximity to the federal centre;
- Development of industrial production;
- A large share of the urban population;
- The presence of one (or more) strong higher education institutions or research organisations in the region.

Among the most developed industries we should mention engineering, oil refining, power industry and information technology. At the bottom of the list there are the national republics, which have both low GRP and level of knowledge economy development. Nevertheless, it is evident that the difference in terms of the regions cannot be explained solely by differences in the natural, geographical conditions or industrial development. The institutional structure of the region has a significant impact on the formation of the knowledge economy. It is the key difference between the leaders and laggards. Therefore, our further research will focus on the institutional analysis of the Russian regions and the construction of an optimal institutional model of the regional economy modernisation based on the achievements of the knowledge economy. This model can be transplanted into regions either in Russia or other country with a transition economy.

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