The Influence of Information and Communication Technologies on the Regional Innovative Activity

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Abstract

Mechanisms for the assessment of the influence of information and communication technologies (ICT) on a number of significant indicators of the economic and innovative development of regions, such as gross regional product (GRP) per capita, the innovative activity of enterprises, the quantity of innovative technologies used at the enterprise level in the region and the volume of the realised innovative production are considered.

The main objective of the present research is the development of a methodological approach for the analysis of connections and dependencies between regional informatisation growth rates and some of their economic and innovative indicators.

In this paper, an integrated indicator of the informatisation of the economy, comprising the main indicators used in international and Russian research in the analysis of the development of information and communication technologies, is presented along with econometric models constructed for the analysis of the efficiency of information and communication technologies applied in regions of the Russian Federation.

Along with their correlation dependencies, the derived statistical results testify that ICT development is one of the most important factors influencing economic growth and innovative activity within regions.

As a result of the conducted research, it is possible to draw a number of conclusions. The development of ICT at the level of the region is one of the main tasks of its social and economic progress. The innovative and rational application of information and communication technologies can become the basis for the creation of a uniform economic information space, both within Russian regions and applying to the country in general, that will allow the realisation of a socio-economic development strategy. The development and practical deployment of models for assessing the influence of informatisation on the development of the economy of regions makes it possible to establish priorities in the choice of factors for increasing their competitiveness.

Keywords: Information and Communication Technologies, Economic Models, Assessment, Social and Economic Development, Region

1. Introduction

In recent times, the rapid development of information and communication technologies has exerted an enormous impact on the transformation of economic relations (Toffler, 2010; Bell, 1973; Kupriyanova & Efimova, 2014). The informational resource, which began to exert an increasing influence on economic development, is now a significant determinant of economic potential. A noticeable acceleration of technical progress, work automation, increase in supply and demand in the service and information sectors, the emergence of a new type of resources used in production processes influencing labour productivity and costs, and the increased information content of manufactured products, are seen as the signs of a new development stage. The emergence of the globalised Internet accompanied by the development of associated computer equipment promoted the emergence of new economic categories. Electronic trading, electronic money and other innovations are now part of the lifeblood of contemporary society. This activity developed new institutional forms, with network-based organisations taking the place of traditional, sufficiently studied forms, e.g. hierarchical (Popov & Simonova, 2015; Popov, 2008; Ershova, 2007). Economic institutions, based on the interaction of agents by means of information and communication technologies,

were created. In the contemporary literature for the description of this development model, such terms as "information economy", "network economy", "post-industrial economy", etc. are used.

In an information society, economic potential depends on the quality and volume of information, as well as the uses to which it is put. At the present stage of development of Russian society, information resources play a strategically important role (Karishev, 2010). Information is the primary object and means of facilitation of labour, finding its material embodiment in all factors and products of social production; as such, it is already a major component of gross domestic product. The presence of information began to influence the productivity of all other factors of production.

Contemporary Russian society has become an active participant in these changes. In order to study the processes taking place in the economy under the conditions of its informatisation, it is important to understand the role of the information resource and the extent of its influence as a factor of economic growth. Such an approach will allow the identification of opportunities, which are presented by the informatisation of the development of the various countries. It is important to understand what social and economic effects are rendered by information technologies on the life of modern society, as well as to examine the existing problems and develop means for their resolution. Surprisingly, a review of the Russian literature reveals that researchers pay little attention to a study of the influence of information and communication technologies on social and economic processes. However, according to a number of well-known western researchers, it is exactly thanks to the development of ICT that a number of countries have managed to make a breakthrough in their development, having replaced their industrial economy with a highly effective post-industrial economy based on information and knowledge.

The main purpose of the present research is the development of a methodological approach for the analysis of connections and dependencies between regional informatisation growth rates and some of their economic and innovative indicators.

2. Literature Review

In article (Karishev, 2010), mechanisms of statistical research into information and communication technologies are considered. The author identifies the ICT as an important element of economic production. The model of informatisation of the economy, describing the formation of the result of economic production, is based on an assessment of the influence of the integrated information and communication indicators (determined by the author as: "hardware", "software" and "telecommunications"), and also the "innovative" factor. The research concludes that the greatest value for the studied economic indicators is rendered by ICT development indicators such as levels of investment into innovations, software and communication, including the Internet.

A number of authors note the importance of ICTs in the modern economy. In work (Bazzazan, 2009), the influence of information technologies on the economic growth of Singapore is estimated. In other researches (Heng & Thangavelu, 2010), an analysis of the resources allocated and economic benefits received is used to study the influence of the information and communication sector on the economy as a whole. As the authors note, the important indicators providing valuable information about the importance of the ICT sector in the modern economy can be estimated by means of the "input-output" tables.

The system of econometric equations constructed in (Arhipova & Gribova, 2012) permits the allocation of factors having a direct influence on the development of the ICT sector in the Russian economy. As the authors note, "regular monitoring of processes in the ICT sphere and modelling of the indicators having an impact on the main productivity characteristics of this sector will allow the necessary information for the persons making administrative decisions and also for heads and businessmen of various level to be obtained."

The analysis of the development of the ICT sector in Russia has revealed a number of problems. A key problem is the digital inequality between territorial subjects of the Russian Federation (Abdrahmanova & Kovaleva, 2009), whose solution lies not only in the technical plane, but also demands a number of social transformations, including the readiness of the population to acquire knowledge and skills in the information and communication sphere. This research also presents conclusions concerning the significant contribution of modern information technologies to the gross internal product (GIP). Characteristics of the ICT-sector in the Russian economy are defined in (Safiullin, 2013). In the Russian ICT sector development scenario, signs characteristic of the catching-up of development are observed (growth of telecommunications against a lag in a software development service delivery). This is amplified by influence from the prevailing sectoral structure, the current economic situation and the specifics of Russian industrial development. Disproportionate sectoral development specifics have a symmetric impact on the ICT market, influencing demand for informational products. Additionally, strong impacts on the development of the Russian ICT

sector are exerted by importation. Overcoming these problems, according to the author, will provide a number of advantages of a global scale to our country and its citizens, improve administration, allow the population of remote regions to access high-quality services and increase the international competitiveness of the country.

In (Magomedgadjiev, 2009) the influence of ICT on labour productivity in regions is considered using correlation and regression analysis methods. In this work, conclusions about the influence of ICTs for labour productivity growth are presented. The efficacy of this influence, which can vary across different regions, is defined by the difficult interaction between information technologies and a number of additional factors, such as the relative strength of the hi-tech sector of the economy, the presence of professional managers working in the IT sphere, general business conditions, access to scientific and technical developments, etc. In (Mitrofanov, 2013) the interrelation of the major factors of the integrated indicator of the level of information and communication development with key socio-economic indexes is considered on the example of regions of the Volga Federal District. Such ICT factors as education, hardware-software provision, information and stimulation of innovative development positively influence gross regional product and the unemployment rate.

The conducted literature review has enabled a systematisation of ICT indicators used in an assessment of their influence on socio-economic development. Results are given in table 1.

Table 1. Analysis of models for assessing the influence of ICT on socio-economic development

Authors	ICT factors	Resultant indicators
Kleibrink A.	ICT development strategy, investment	households having Internet access
Niehaves B.		
Palop P.		
Sörvik J.		
Thapa B.		
Nikolaidis et al.	Use of personal computer, Internet access, existence of e-mail	readiness for innovations and business
James J.	Internet distribution, telephony, computers	quality of life, human capital
Welfens P. J. J.	ICT investments	gross internal product (GIP)
Perret J. K.		
Magomedgadjiev Sh.	Costs of ICT, number of personal computers of 100 workers	indicators of scientific, technical and innovative development (number of organisations carrying out scientific research and development; number of granted patents for inventions and useful models; number of advanced production technologies used; volume of innovative goods), labour productivity
Arhipova M. *Gribova E.*	number of personal computer; special software; anti-virus software; use of Internet for commercial purposes; cooperation.	average turnover of organisations; shipped (sold) goods (works, services) of ICT sector
Karishev M.	hardware, software, telecommunication, innovative	gross regional product
Mitrofanov E.	education, provision of hardware-software, information factor, innovative development	gross regional product, unemployment rate, investments into fixed capital

Source: made by authors with materials (James, 2009; Kleibrink et al., 2015; Nikolaidis et al., 2013; Welfens & Perret, 2014).

The German expert A. Jipp was one of the first to note the existing interrelation of parameters of economic development and telecommunications development indicators (Jipp, 1963). Having analysed statistics of 1959 honour over 120 countries of the world, the scientist has constructed the schedule of dependence of telephone density to GDP per capita. Further, this schedule became known as "Jipp's chart". As a first approximation, it is possible to consider that the dependence which was empirically established by A. Jipp has a linear character:

$$D = a \cdot G \quad \text{(Eq. 1)}$$

D – telephone density;

G – GDP per capita;

a – normalising indicator.

The Russian scientists and experts led by V. B. Bulgak and L.E. Varakin have formulated and proved the economic information law (Bulgak & Varakin, 2000): the volume of information created in a country in a year in the course of a macroeconomic turn is proportional to its gross domestic product (GDP). In terms of its character, this dependency is close to the correlation dependence of the Jipp's chart.

3. Calculation Procedure and Analysis of Data

The considered models for assessing the influence of ICTs on various social and economic and innovative indicators are, in our opinion, notable in terms of a lack of data of a static character, complicating an assessment of indicators in dynamics. The above-considered models do not take into account such important resources in the modern information world as time. In order to eliminate this shortcoming, we propose to consider indicators of information and communication development in terms of their dynamics. On the basis of the data published by the Federal State Statistics Service in the annual "Regions of Russia – socio-economic indexes" collection, we propose to use the complex indicator of ICT development including the following 14 variables: volume of communication services rendered to the population; number of mobile telecommunication subscribers per 1000 people; proportion of organisations using PCs; computers of other types; local computer networks; Internet access; number of organisations with a website; number of PCs per 100 employees; number of PCs with Internet access; number of organisations using specialised software; computer facility acquisition costs; software acquisition costs; employee training costs; cost of fees paid to third-party organisations and ICT experts. The majority of these indicators, widely used by international organisations, are key to an assessment of the development of ICT and, as such, have served as the basis of statistical data between 2002 and 2012. Territorial subjects of the Russian Federation considerably differ from each other in terms of the level of technological development. Therefore, in order to receive a uniform selection, the proportion of regions having a significant deviation of indicators from the average value has been excluded from the research. The calculation of a complex indicator of ICT development is performed using the formula:

$$S = \frac{\sum_i^n p_i}{n} \quad \text{(Eq. 2)}$$

p_i – value of factor of development of ICT;

n – quantity of factors;

The following output indicators are used: gross regional product per capita; innovative activity of enterprises; innovative technologies used; volume of innovative production. The empirical research is based on the following assumptions:

1: The higher the average regional ICT development rate, the higher the GRP per capita indicator for that region.

2: The higher the average regional ICT development rate, the higher the innovative activity of the enterprises based in that region.

3: The higher the average regional ICT development rate, the greater the quantity of innovative technologies used in the region.

4: The higher the average regional ICT development rate, the higher the volume of innovative products brought to market.

Thus, in order to check the hypotheses against the data we calculated the average growth rates of the integrated regional informatisation indicator, as well as average GRP growth rate values and innovative activity, products and services. The formula used to calculate dynamic indicators has the following appearance:

$$T = \frac{\Sigma(\frac{Q_i}{Q_{i-1}} * 100)}{n} \quad \text{(Eq. 3)}$$

T – average growth rate of an indicator;

Q_i *– indicator for i-y year;*

n – number of years;

Fig. 1 shows the results from checking the first hypothesis. The conclusion can be drawn that there is a significant correlation dependency between average growth rates of regional informatisation and GRP per capita (correlation coefficient r=0.61). Thus, it is possible to conclude that the development of ICT as a factor of economic growth positively influences the development of the region, increasing its competitiveness.

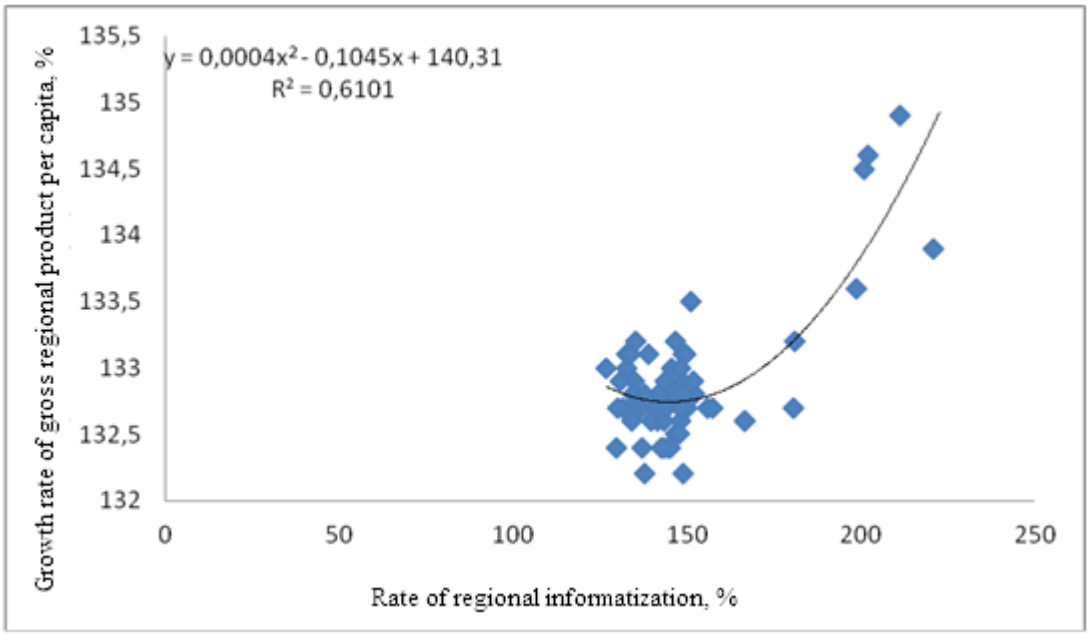

Figure 1. Correlation dependence between average rate of informatisation of the region and average growth rate of GRP per capita, %

In order to check the second hypothesis, we constructed the schedule of dependence between the innovative activity of regional enterprises and the ICT factor (figure 2). In this case, an average dependency correlation level of r=0.51 is observed.

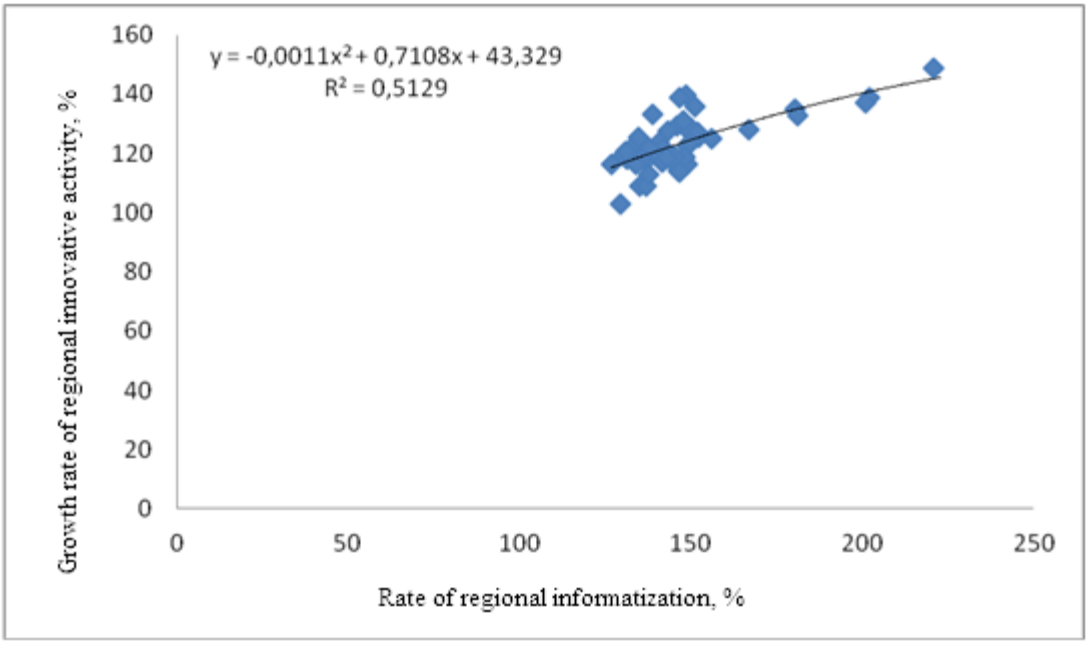

Figure 2. Correlation dependence between average rate of informatisation of the region and average growth rate of innovative activity of the enterprises, %

The confirmation of the third hypothesis has shown that communication between informatisation of regions and average growth rate of the innovative technologies used is insignificant (correlation coefficient of r = 0.41). Thus, it is possible to note that such factors as informatisation of the economy rather poorly influence the use of innovative technologies. In our opinion, the introduction and further use of innovative technologies is also likely to depend on other factors, such as financing, a sufficient educational and qualification level of personnel and some other factors.

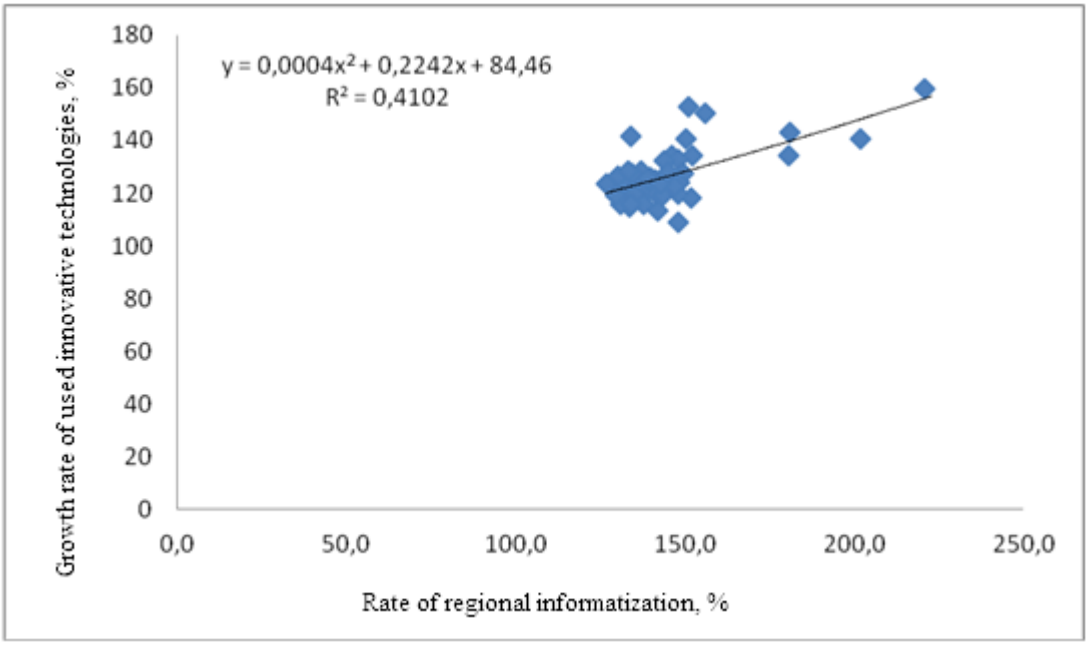

Figure 3. Correlation dependency between average rate of informatisation of the region and average growth rate of employed innovative technologies, %

The smallest level of correlation dependence is observed when checking the fourth hypothesis of the interrelation of the average rate of informatisation of the region and the growth of volumes of innovative production in this region (r = 0.18). In our opinion, this is also explained by the fact that the end result of innovative activity, i.e. growth of

volume of innovative production, also significant affects some other factors of innovative activity, which are not considered in the actual research. However, the graphical analysis of the schedule represented in Fig. 4 shows a positive correlation between the development of ICTs in the region and the growth of innovative production.

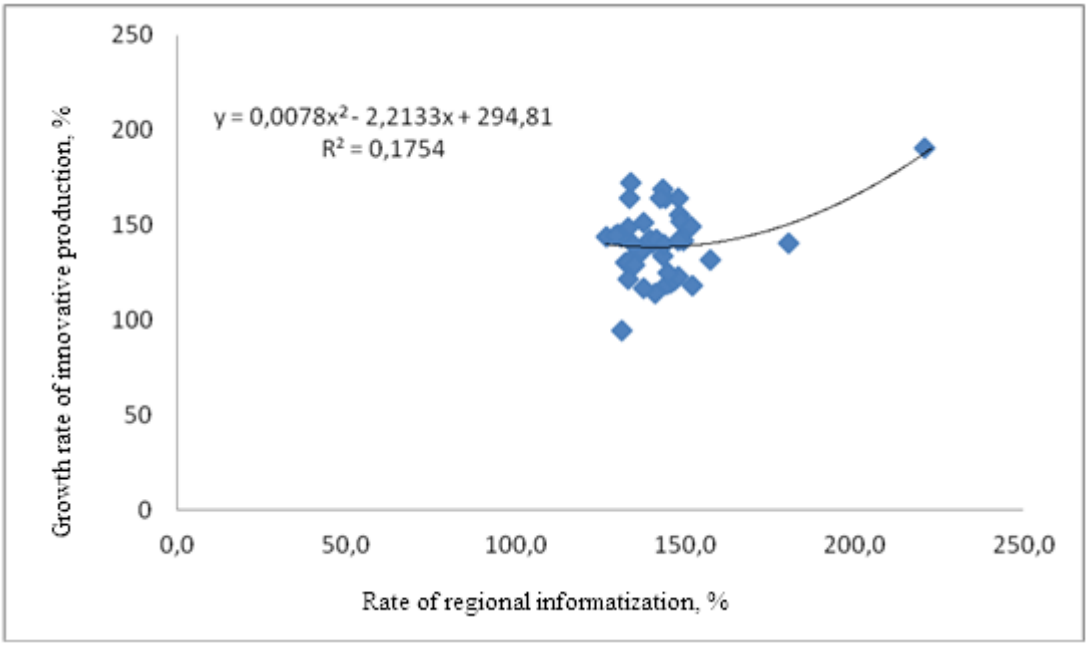

Figure 4. Correlation dependency between the average rate of informatisation of the region and the average growth rate of innovative production, %

4. Conclusion

As a result of the conducted research, it is possible to draw a number of conclusions. The development of information and communication technologies at the regional level is one of the main tasks of its social and economic development. The innovative and rational application of ICTs will become the basis of the creation of a uniform economic information space, both in the regions of Russia and across the country as a whole, that will allow an economic and social development strategy to be realised.

As a result of the conducted research, it became possible to confirm the hypotheses concerning the influence of the level of informatisation of regions against a number of indicators of economic and innovative activity. The statistical models constructed on the basis of the calculated integrated indicator of informatisation of regions show a dependency between the average growth rate of this indicator and the average growth rate of such indicators as a gross regional product per capita, the innovative activity of enterprises, the specific innovative technologies employed and volume of innovative production.

The development and practical deployment of the modelled assessment of the influence of informatisation on the development of the economy of regions provides an opportunity to form priorities in the choice of factors that result in an increase of their competitiveness.

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