Analysis and Prospects of the Digital Economy in Russia

Evgenii Konnikov¹, Yulia Dubolazova*, Olga Konnikova² and Ekaterina Malevskaia-Malevich¹

¹ Peter the Great St. Petersburg Polytechnic University, Saint Peterburg, Russian Federation
² St. Petersburg State University of Economics, Saint Peterburg, Russian Federation

*E-mail: dubolazova_yua@spbstu.ru

Abstract.
The beginning of the 21st century saw the development of digital technologies due to the information revolution and globalization processes. Information has become a principal resource in the society and business processes. A person can transform it into knowledge and social and economic relationships are migrating into the network space. The digital culture is a key factor of the digital transformation. Comprehensive introduction of state-of-the-art digital technologies is one of the growth areas for the economy as they change business processes, communications and the social sphere and, as a result, create the new “digital” culture. The authors of this paper focus on the fact that in the nearest future the majority of technologies will be developed at the intersection of various interrelated industries, from 3D printers to cloud computing and mobile applications. The paper also explores the ways various governments deal with the changes resulting from the digital economy and the costs they incur to arrange the interaction of citizens with public authorities using various digital technologies. These and other factors make the article relevant. The subject matter of the paper is digital technologies, which are crucial for Russia’s economic development. The goals include the research of the state of the digital economy in Russia and in the world, analysis of the digital economy program as a priority for the country’s economic development and determination of the economic digitalization prospects. The research is based on such methods as examination and generalization, analysis and synthesis, as well as comparative analysis, which made it possible to specify basic digital economy trends.

Keywords: digital economy, new technologies, “digital culture”, cybersecurity.

1. Introduction
Digital technologies in the Russian economy are a new reality providing for efficient fundamental solutions that allow for the high standards of the scientific and technological knowledge application. Innovations are based on digital technologies and business models that efficiently use information and communication technologies (ICT). The Russian government can provide incentives to businesses under government programs for innovations to be introduced into the economic and social sphere, which is one of the key development factors for the country.
The Russian economy, despite an existing stereotype about its focus on raw materials, has other “supports” as well. According to the Federal State Statistics Service’s official data, the following industries formed Russia’s gross domestic product (GDP) in 2017: wholesale and retail trade, automobile and motorcycle maintenance (13%); processing industries (11.9%); net taxes on products (9.8%); extraction of natural resources (9.4%) and real estate transactions (8.9%). These data show that there is no critical dependence of the economy on natural resources.

However, for the Russian economy to enter the next technological development cycle involving digitalization and high-tech solutions, it is necessary to make GDP dependant on information operations (last year they accounted only for 2.1% of GDP), education (2.3%), healthcare and social services (3.3%) and professional, scientific and technical activities (4.3%).

Government should make efforts to maintain favorable conditions for competition between ICT companies and to add value to the economy. The ICT sector will provide for a significant inflow of targeted investments, both domestic and foreign. This will be possible in case of the implementation of the program titled “Digital Economy in the Russian Federation” of Resolution of the Russian Government No. 1632-p dated July 28, 2017 [1].

That program has the following objectives:

- create the digital economy ecosystem in the Russian Federation where digital data are the key production factor in all social and economic spheres and which provides for the efficient cooperation, including cross-border cooperation between business, scientific and educational community, government and citizens;
- create required and sufficient conditions of the institutional and infrastructural nature, eliminate obstacles and restrictions for new and/or existing high-tech businesses and prevent new obstacles and restrictions both in traditional industries and in new industries and high-tech markets; and
- improve the competitive potential of individual Russian industries and the Russian economy on the whole on the global market.

The Russian government plans to implement that program during the period from 2017 to 2030 by social and legal regulation and making laws compliant with the reality of the digital economy, as well as by protecting citizens’ rights and personal data. It will also require the development of the state digital ecosystem that connects various government institutions and social spheres, including further education of personnel working in state-owned enterprises. The program is also aimed to provide access for all citizens to the Internet and various aspects of the digital economy.

On the whole, the program shows that the government is on the right track to the development of the digital economy, however it does not contain much detail. The goal of this paper is thus to analyze the digital economy trends in Russia. The following objectives are set to achieve the goal: 1. conduct an empirical analysis of modern science related to digital and other state-of-the-art technologies in Russia to determine to which degree it is developed; 2. analyze the penetration of basic digital technologies into the society and employment in industries connected with the digital economy; and 3. conduct an econometric analysis to determine the impact of each indicator on GDP per capita and average wage.

1.1. Literature review

The research involved an analysis of various publications on the digital economy.

The digital economy is currently on the rise in Russia. “Russian business has mainly joined the “digital race”. Company employees and managers understand that without digital technologies they will not be able to compete either on the domestic or foreign markets any longer…” [5]. Government is responsible for the implementation of certain standards, which will allow for easier integration of various systems in the future. “The specific nature of the Russian economy makes government a rather prominent player on the market, so it is possible to stimulate business development by creating appropriate demand for digital products…” [5].

Nevertheless, the modern society does not have the “digital culture” yet. A.A. Shakirov believes that “the lack of the digital culture and low technological literacy among general public may be harmful for certain companies or even industries” [3].

Digital technologies help to optimize routine processes and cut expenses. N.A. Zhuravleva analyzes “the digital economy from the perspective of logistics by regarding delivery time and product ownership period as important characteristics of business process efficiency. Technologies offered by the digital economy provide an opportunity to conduct a qualitative analysis of transaction execution periods and to minimize differences between planned and actual execution periods” [7].
The “brain drain”, the main problem in the IT industry mainly caused by political and economic reasons, can be stopped only by radical transformations of the government policy. B. Panshin says that “attention is paid to the ways different governments deal with changes inherent to the digital economy and which costs they incur to arrange interaction between citizens and public authorities using various digital technologies. The author believes that the defining role in digitalization should be played by government, rather than by private companies, which is happening in Asian countries unlike the USA” [2].

2. Methods

The research used methods of empirical, econometric and correlation analysis. Empirical analysis is based on the assumption that GDP per capita in rubles and average wage in rubles will be the main indicators that show the state of the country’s economy. These two indicators will show changes in the economy as such and changes in citizens’ well-being. Three main environments combining several indicators were selected as the factors affecting these indicators. These are economic, scientific and social environments. The selection covers all relevant factors. The environments are represented by the following factors.

Economic environment:
1. IT market size.
2. IT export share.
3. Share of cross-border M&A transactions.
4. Government funding of science (% of GDP).
5. Government funding of science (% of the budget).

The IT market is one of the most economically significant parts of the digital economy and its development in a particular country clearly indicates its development stage. Historically, it is government that funds fundamental science in Russia, therefore this indicator may show whether government pays attention to this sphere.

Scientific environment:
1. Total number of patents.
2. Total number of IT patents.
3. Share of IT patents.
4. Nanotechnologies used.
5. Nanotechnologies developed.
6. ICT publications.
7. Number of supercomputers in the TOP 500.

These indicators show the development stage of the modern science related to digital and other state-of-the-art technologies in Russia, from research papers and patents to specific practical studies. Such parameter as the number of supercomputers was also added to reflect the country’s computing capacity allowing for scientific and more practical computations.

Social environment:
1. Share of Internet users.
2. ICT employee population.
3. IT employee population.

These indicators show the penetration of basic digital technologies into the society and employment in industries related to the digital economy.

Figure 1 shows the model built as a mind map.

![Mind map diagram](image-url)
The period from 2011 to 2017 was subject to analysis. This period is characterized by relatively the same political and economic agenda of government, which indicates that the government policy affects to a greater or lesser extent the development of the digital economy in Russia in the 21st century. The majority of data are taken from the official website of the Federal State Statistics Service [9]. The following variables were assigned to the parameters selected (table 1).

| Variables | Name |
|-----------|------|
| Y1        | GDP per capita (RUB) |
| Y2        | Average wage (RUB)   |
| X1        | IT market size       |
| X2        | Share of IT export in all export, % |
| X3        | Share of IT patents  |
| X4        | Share of cross-border M&A transactions in the ICT industry |
| X5        | Number of registered IT patents (qty) |
| X6        | Cumulative number of registered patents (qty) |
| X7        | Government funding of science (% of the budget) |
| X8        | Government funding of science (% of GDP) |
| X9        | Number of supercomputers in the TOP 500 |
| X10       | Share of Internet users (%) |
| X11       | ICT employee population (qty) |
| X12       | IT employee population (qty) |
| X13       | Number of nanotechnologies used in Russia (qty) |
| X14       | Number of nanotechnologies developed in Russia (qty) |
| X15       | Number of ICT publications (qty) |

The following two equations were composed to conduct an econometric analysis:

\[
Y_1 = a_1 \times X_1 + a_2 \times X_2 + a_3 \times X_3 + a_4 \times X_4 + a_5 \times X_5 + a_6 \times X_6 + a_7 \times X_7 + a_8 \times X_8 + a_9 \times X_9 + a_{10} \\
\times X_{10} + a_{11} \times X_{12} + a_{13} \times X_{13} + a_{14} \times X_{14} + a_{15} \times X_{15} + b \\
Y_2 = a_1 \times X_1 + a_2 \times X_2 + a_3 \times X_3 + a_4 \times X_4 + a_5 \times X_5 + a_6 \times X_6 + a_7 \times X_7 + a_8 \times X_8 + a_9 \times X_9 + a_{10} \\
\times X_{10} + a_{11} \times X_{12} + a_{13} \times X_{13} + a_{14} \times X_{14} + a_{15} \times X_{15} + b
\]

These equations will be later used to determine the impact of each of the indicators on GDP per capita and average wage. Then the pool of factors affecting each of the two indicators will be compared and the impact will be analyzed.

Due to the fact that the data on certain key indicators, namely the number of nanotechnologies used in Russia, the number of nanotechnologies developed in Russia and the number of ICT publications, are available only for the period from 2010 to 2018, it was decided to divide the model into two parts.

Two models were built during the research. The first model has 12 variables analyzed during 17 time periods (2001-2017) and is named Model_B. The second model has three additional variables with data available only for 8 time periods and is named Model_M. The correlation analysis of each of the models was then performed to eliminate variables that duplicate each other. The high correlation degree was determined for values from 0.86 and higher. Then lines and columns with variables were consecutively eliminated starting from variables that correlate with several others at the same time: the share of IT patents, the share of cross-border M&A transactions in the ICT industry, the number of registered IT patents (qty), and the cumulative number of registered patents (qty). Then questionable variables left were analyzed for lower values of correlation with other factors taking into account a merely logical factor. For example, the government funding of science as a percentage of GDP was selected out of two variables reflecting government funding of science, although they had almost equal correlation with other factors, but it was taken into account that GDP per capita would be used for further analysis.
The model optimization is an important stage of the further research that requires, first of all, a correlation analysis to eliminate variables that duplicate each other. Secondly, the model should be optimized by a regression analysis to eliminate variables that do not affect the two analyzed indicators that much. R-squared and normalized R-squared, as well as an approximation error should be traced at the same time to understand the overall quality of the model.

3. Results and Discussion

An additional correlation analysis was conducted based on the research results to verify the variable that was different in the two initial models. The analysis showed high correlation of that variable, so it was eliminated and the list of six variables was finalized for the period from 2001 to 2017:

- IT market size.
- Share of IT export in all export, %.
- Share of cross-border M&A transactions in the ICT industry.
- Government funding of science (% of GDP).
- Number of supercomputers in the TOP 500.
- Share of Internet users (%).

A regression analysis was conducted after the correlation analysis. GDP per capita and average wage were used in sequence as Y. Six variables left after the correlation analysis were used as X. As a result of the first stage of the analysis with GDP per capita, R-squared equalled 0.994 and normalized R-squared equalled 0.991, which is more than sufficient. P-values for all variables are shown in Table 2.

| Indicators                                      | P-value        |
|------------------------------------------------|---------------|
| Y-intercept                                    | 13.72%        |
| IT market size                                 | 3.10%         |
| Share of IT export in all export, %            | 79.35%        |
| Share of cross-border M&A transactions in the ICT industry | 68.37%        |
| Government funding of science (% of GDP)      | 50.57%        |
| Number of supercomputers in the TOP 500       | 10.92%        |
| Share of Internet users (%)                   | 0.00%         |

Three variables were then eliminated (share of IT export in all export, share of cross-border M&A transactions in the ICT industry and government funding of science (% of GDP)) as their values were way over required 10%. As a result, p-values for the variables left decreased even more and the final model had three variables:

- IT market share
- Number of supercomputers in the TOP 500
- Share of Internet users

The model’s R-squared was 0.9933 and normalized R-squared was 0.9917. Fisher criterion was 2.3, when the table value in that case was 3.2, which is an adequate variance. The average approximation error was 5.86%. The second part of the model was analyzed similarly. Average wage was taken as Y. R-squared equaled 0.9921 and normalized R-squared equaled 0.9873, which is also in line with the requirements. P-values for all variables are presented in Table 3.

| Indicators                                      | P-value        |
|------------------------------------------------|---------------|
| Y-intercept                                    | 65.24%        |
| IT market size                                 | 7.70%         |
| Share of IT export in all export, %            | 2.31%         |
| Share of cross-border M&A transactions in the ICT industry | 70.21%        |
| Government funding of science (% of GDP)      | 62.00%        |
| Number of supercomputers in the TOP 500       | 8.13%         |
| Share of Internet users (%)                   | 0.00%         |

Two variables (share of cross-border M&A transactions in the ICT industry and government funding of science (% of GDP) were eliminated as a result as their values were way over 10%. Another analysis was then conducted and decreased p-values of all variables even more. The final model had four variables:
• IT market size,
• Share of IT export in all export,
• Number of supercomputers in the TOP 500,
• Share of Internet users (%).

Fisher-criterion was 2.8, while the table value in that case was 2.96, which is an adequate variance. The average approximation error was 5.79%.

Two models were built as a result, one of them showed the impact of three factors on the GDP per capita in Russia during the period from 2001 to 2017 and the second one showed the impact of the same three factors plus one more on the average wage in Russia during the same period.

4. Conclusions

F-criterion equaled 2.87, while the table value in that case was 2.96, which is an adequate variance. The average approximation error was 5.79%, it can thus be concluded that there is at least one factor in the selected spheres (economic, scientific and social) that has an impact on the both models. It means that the digitalization of the economy has an overall impact on all economic spheres. The share of Internet users in the total population is a factor that has a big impact on both analyzed indicators, i.e. average wage and GDP per capita. It also shows high dependence of the economic growth on the Internet penetration level. Internet access, on the one hand, expands potential markets for customers and vendors and, on the other hand, creates jobs in the IT sector as a sector responsible for the technological side of the digital economy and additional jobs for those who provide goods and services that would be difficult or impossible to imagine otherwise. That indicator is interrelated with the growth of average wage and GDP per capita. Internet penetration among population, especially among senior citizens, can speed up digitalization of the economy on the whole, decrease paperwork and provide for time and resource savings. Space satellites are the most promising method to cover distant districts with high-speed Internet, although it is cost effective only in cooperation with other states and international corporations.

The same explanation may be given about the impact of the IT market size on both factors.

Both factors are also affected by the number of supercomputers in the Top 500. That indicator reflects readiness of government and big business to make big investments to create and upgrade systems intended for large-scale computations. A significant number of supercomputers is likely to mean that there are technologically-difficult projects (space industry, aircraft engineering, infrastructure, energy etc.), which may require significant computation capacity for modeling. This, in its turn, indicates that the economy is rather developed and can fund such kind of projects. Therefore, an increasing number of supercomputers can be considered a factor affecting GDP per capita and average wage. Except for secret military supercomputers, all of them are made of foreign components, so the market open for import of high-tech electronics can stimulate the development of computational systems in the country and, therefore, make their use by companies cheaper and help companies create more accessible high-tech products, which can be a potential impetus for the economic development.

Average wage is also affected by the share of IT export in total export. Wages of IT specialists in Russia are, as a rule, above average in the country, which is caused primarily by the fact that it is a universal industry with the same foundation as in other countries in the world. Despite the fact that many new IT specialists graduate every year and regardless of their quality, there is a serious deficit of qualified IT personnel in Russia. The reason is that many specialists prefer to move to Western Europe, North America and sometimes Asia, where wages are significantly higher. This makes Russian IT companies offer wages higher than average in the country, especially in the companies that export IT services.

The above conclusions show that the nearest future is unlikely to bring significant changes related to the development of the digital economy and the authors’ future research will be dedicated to the elaboration of specific digitalization measures for Russia based on international best practices.

References

[1.] Resolution of the Government of the Russian Federation No. 1632-p dated July 28, 2017 on the approval of the program "Digital Economy in the Russian Federation".
[2.] Panshin B. Digital economy: development specifics and trends // Science and innovations. — 2016. — No. 157. — Pages 17-20.
[3.] Shakirov A.A., Zaripova R.S. The role of new technologies in the economy of the 21st century: threats and challenges of the digital economy // Economy today: Current state and development prospects (Vector-2018). — Moscow: Kosygin Russian State University, 2018. — Pages 331-334.

[4.] Yakutin Y.V. Russian economy: Digital transformation strategy (constructive criticism of the government program "Digital Economy in the Russian Federation") // Management and business administration. — 2017. — No. 4. — Pages 27-52.

[5.] Report of the HSE Institute of Innovation Management "Digital economy: global trends and Russian business practice" Oganesyan T.K., Styirin E.M., Abdrrakhmanova G.I., Rozmirovich S.D., Merkulova D.Y., Bikbulatova Y.S., 2017

[6.] Zubarev A.E. Digital economy as a pattern of the new economic development // Pacific National University Bulletin. — 2017. — No. 4 (47). — Pages 177-184.

[7.] Zhuravleva N.A. Digital economy as the foundation of the high-speed economy // transport systems and technologies. — 2017. — No. 2 (8). — Pages 47-49.

[8.] Solzhentsev E.D. Digital state and economic management // relevant economic and management issues. — 2018. — No. 1 (17). — Pages 136-153.

[9.] Russian State Statistics Service's official website [Electronic resource] – Available at: http://www.gks.ru/— (access date: November 15, 2018)

[10.] Babkin A.V. et al. Digital economy formation in Russia: essence, specifics, technical normalization, development problems /Scientific and technical journal of St. Petersburg Polytechnic University. Economic sciences. – 2017. – Vol. 10. – No. 3.

[11.] Nesterenko E.A., Kozlova A.S. Trends of the digital economy and digital technologies in Russia //Economic security and quality. – 2018. – No. 2 (31).

[12.] Razinkina, E., Pankova, L., Trostinskaya, I., Pozdeeva, E., Evseeva, L., Tanova, A. (2018)/ Student satisfaction as an element of education quality monitoring in innovative higher education institution //E3S Web of Conferences.

[13.] Eliakina, P.D., Evseeva, O.A., Evseeva, S.A., Ilyin, I.V.(2018) /Development of the national innovation system on the base of blockchain technology (case of the Russian Federation)// Proceedings of the 32nd International Business Information Management Association Conference, 7773-7784.

[14.] Zaytsev, A., Kichigin, O., Kozlov, M. (2019) / Rental analysis of innovation component in resource productivity/ IOP Conference Series: Materials Science and Engineering.

[15.] Zhilenkova, E., Budanova, M., Bulkhov, N., Rodionov, D.(2019)/Reproduction of intellectual capital in innovative-digital economy environment // IOP Conference Series: Materials Science and Engineering.

[16.] Progono, L., Voronova, T., Bogatyrev, S., Kostyukova, O. (2019) /Innovative aspects of preferential rules of goods origin in the economy of global chains: Applicability for the Eurasian Economic Union (EAEU) //IOP Conference Series: Materials Science and Engineering.

[17.] Ivanova, M., Garmasar, O., Yakovleva, T., Glyass, E. (2019) / Evaluation of compliance costs interrelation with a level of innovative economic development // IOP Conference Series: Materials Science and Engineering.

[18.] Degtereva, V.A., Zaborovskaia, O.V., Sharafanova, E.E. (2018) /Methodology of targeted support for service sector enterprises in regional economic system// Proceedings of the 31st International Business Information Management Association Conference, 955-966 pp.

[19.] Asatururova, Y., Khvatova, T. (2018). Innovative activity of enterprises under the condition of financial deficit// Proceedings of the European Conference on Innovation and Entrepreneurship, ECIE, 59-67

[20.] Nikolova, L.V., Rodionov, D.G., Afanasieva, N.V. (2017).Impact of globalization on innovation project risks estimation. European Research Studies Journal, Vol 20 No. 2. pp 396-410