

DOI: 10.18721/JE.14201  
UDC 332.05

## STRATEGIZING OF ECONOMIC SYSTEMS DIGITAL TRANSFORMATION: A DRIVER ON INNOVATIVE DEVELOPMENT

D.M. Zhuravlev<sup>1</sup>, V.V. Glukhov<sup>2</sup>

<sup>1</sup> Social systems research institute at Lomonosov Moscow State University, Moscow, Russian Federation;

<sup>2</sup> Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russian Federation

The main directions of the regional economy advanced development include the stimulation of small and medium business, import substitution policy, improvement of the professional qualities of the economically active population, and development of a favorable environment in the interaction of business and government. However, in modern conditions, a new driver of economic growth is needed: the digital transformation. For successful transformations, resulting in a significant increase of efficiency, clearly defined goals and business objectives are required, i.e., the available strategy, implementation of which is realized in the need to achieve a specific state of the economic system, in which its development is ensured through synchronization with national, regional and sectoral priorities. Moreover, along with the preparedness to strategizing, an appropriate external environment is essential, presuming the capabilities of the regional economic system to support innovation. The article presents the authors' approach to the problems of analyzing the processes underlying the regional economy. A purposely designed toolkit consisting of economic and mathematical models, databases, and applied software is aimed to intensify the framework of studying the regional economy development management. The example of the socio-economic system of St. Petersburg enabled to carry out a comprehensive assessment of the consistency of the regional economy in the formation of a favorable business environment for economic entities at the initial stage of digital transformation. The result of the study is the substantiation of the provisions that to reduce the risks of stagnation in economic growth, support of the leading regional enterprises is essential, which act as the leaders of progress, introducing capital-intensive technologies, and conducting digital business transformation. Availability of such poles of growth reduces the barrier in terms of accessing digital technologies for small and medium businesses, thereby ensuring the sustainability and competitiveness of the region as a whole. The paper made it clear that the key to the successful digital transformation is the creation of IT ecosystems that implement the concept of a systematic approach to decision-making in business management, applying knowledge economy technologies, such as predictive analytics, artificial intelligence, big data, cloud computing, etc. Recommendations for the generating of unified information space in the concept of a digital enterprise are provided.

**Keywords:** information system, planning, forecasting, regional economy, development strategy, change management, digital platform, digital transformation, digital twin

**Citation:** D.M. Zhuravlev, V.V. Glukhov, Strategizing of economic systems digital transformation: a driver on innovative development, St. Petersburg State Polytechnical University Journal. Economics, 14 (2) (2021) 7–21. DOI: 10.18721/JE.14201

This is an open access article under the CC BY-NC 4.0 license (<https://creativecommons.org/licenses/by-nc/4.0/>)

## СТРАТЕГИРОВАНИЕ ЦИФРОВОЙ ТРАНСФОРМАЦИИ ЭКОНОМИЧЕСКИХ СИСТЕМ КАК ДРАЙВЕР ИННОВАЦИОННОГО РАЗВИТИЯ

Журавлев Д.М.<sup>1</sup>, Глухов В.В.<sup>2</sup>

<sup>1</sup> Научно-исследовательский институт Социальных Систем  
при МГУ им. М.В. Ломоносова, Москва, Российская Федерация;

<sup>2</sup> Санкт-Петербургский политехнический университет Петра Великого,  
Санкт-Петербург, Российская Федерация

В качестве основных направлений опережающего развития региональной экономики выделяются стимулирование малого и среднего предпринимательства, политика импортозамещения, повышение профессиональных качеств активной части занятых граждан, формирование благоприятного окружения при взаимодействии бизнеса и власти. Однако в современных условиях необходим новый драйвер экономического роста, которым является цифровая трансформация. Для успешного проведения преобразований, результатом которых является существенное повышение эффективности, необходимы четко сформулированная цель и бизнес-задачи, то есть наличие стратегии, смысл реализации которой состоит в необходимости достижения такого состояния экономической системы, при котором ее развитие будет обеспечиваться через синхронизацию с общегосударственными, региональными и отраслевыми приоритетными целями. При этом, кроме готовности самого объекта стратегирования, необходимо наличие соответствующего внешнего окружения, то есть возможностей региональной экономической системы по поддержке инноваций. В статье представлен авторский подход к решению задач анализа процессов, составляющих основу региональной экономики. Разработан соответствующий инструментарий (экономико-математическая модель, база данных и прикладное программное обеспечение), усиливающий аппарат исследования проблем управления развитием региональной экономики. На примере социально-экономической системы Санкт-Петербурга проведена комплексная оценка состоятельности экономики региона по формированию благоприятного бизнес-окружения для хозяйствующих субъектов, находящихся на начальном этапе цифровой трансформации. Результатом исследования является обоснование положений, что для снижения рисков стагнации экономического роста, необходима поддержка ведущих региональных предприятий – лидеров прогресса, внедряющих капиталоемкие технологии и проводящих цифровую трансформацию бизнеса. Наличие подобных полюсов роста позволит снизить барьер доступа к цифровым технологиям для малого и среднего бизнеса, обеспечив тем самым устойчивость и конкурентоспособность региона в целом. Показано, что залогом успешности проведения цифровой трансформации является создание ИТ-экосистем, реализующих концепцию системного подхода к принятию решений по управлению бизнесом, используя для этого технологии экономики знаний, такие как предиктивная аналитика, искусственный интеллект, большие данные, облачные вычисления и пр. Даны практические рекомендации по формированию единого информационного пространства в концепции цифрового предприятия.

**Ключевые слова:** информационная система, планирование, прогнозирование, региональная экономика, стратегия развития, управление преобразованиями, цифровая платформа, цифровая трансформация, цифровой двойник

**Ссылка при цитировании:** Журавлев Д.М., Глухов В.В. Стратегирование цифровой трансформации экономических систем как драйвер инновационного развития // Научно-технические ведомости СПбГПУ. Экономические науки. 2021. Т. 14, № 2. С. 7–21. DOI: 10.18721/JE.14201

Это статья открытого доступа, распространяемая по лицензии CC BY-NC 4.0 (<https://creativecommons.org/licenses/by-nc/4.0/>)

## Introduction

The global economy has recently been undergoing significant structural changes, resulting in a gradual abandonment of technologies, involving unskilled labor and high operating costs, to support production and business processes (management, logistics, sales, warehousing, maintenance). The emphasis is on capital-intensive production fit to operate almost automatically and focused on the production with high added value by minimizing operating costs. The reason for this is the drastic growth of so-called high technologies based on digital data processing (collection, analysis, modeling, forecasting, process control, etc.) and the possibility of obtaining energy from renewable sources (green power industry) [1]. New means of payment, such as cryptocurrency, are emerging along with different types and methods of communication

embedded in production processes. Taken together, this leads to the need to revise the existing industrial and social relations, develop new strategies and actualize the features of socio-economic development, ensuring sustainable economic growth [2]. Moreover, considering the peculiarities of the Russian economy, these tasks should be solved mainly at the regional level since the federal level deals with global goal-setting (national projects), legal regulation (favorable business environment), general management, and control over the fulfillment of social obligations. The subjects of the Russian Federation fully participating in economic, business, political, and financial relations are meant to be the flagships of the national economy. Those regions with historically the most favorable conditions, obtaining sufficient raw material and human resources potential, should act as innovators, that is, to guide new technologies that have been tested in leading regional enterprises and recognized suitable for scaling and replication. This condition is essential to equalize the socio-economic situation in the regions and to ensure equal conditions and quality of life for citizens, regardless of their place of residence.

The implementation of the announced approach leads to the need for a radical restructuring (digital transformation) of technological processes and principles of management of large industrial enterprises, being the drivers of economic growth and the basis for the development of small and medium businesses. Digital transformation for enterprises striving both to maintain their positions in the market and to create a background for long-term development means:

1. A growth pole that ensures business diversification by stimulating the creation of new products, facilities, and services through digital technologies, possessing the adaptive and integration capabilities significantly higher than traditional ones [3].
2. The possibility of obtaining added value by optimizing business processes at all levels, reducing non-productive costs, increasing labor productivity, and extensively use the digital competencies of personnel [4].
3. Early arrangement of conditions for gaining access and conflict-free implementation of emerging new and complementary technologies [5, 6].

The list of national specialists whose work is devoted to assessing the level of socio-economic development and the region's readiness for transformations, studying the conditions and limitations of digital transformation, includes the names of such researchers as M.Yu. Arkhipova [7], L.G. Matveeva [8], I.V. Mitrofanova [9], A.A. Urasova [10], and others. Statements about the need to identify and take into account the set of influencing and stimulating factors in the formation of strategies and rules of behavior in competitive markets of economic entities are found in V.V. Akberdina [11], E.V. Balatsky [12], G.V. Korovin [13]. The basic principles underlined by new economic categories, such as the informational capacity of employment of the population, digital competencies of personnel, workplace information components that determine the strategy formation approaches to the involvement of the population in the digital economy, are stated by I.V. Novikova [14].

It should be noted that to achieve a complete process of digital transformation, well-defined tasks and business objectives are required. This presumes an available strategy, the implementation purpose of which is to ensure the enterprise development in synchronization with national, regional, and sectoral priority goals. Therefore, before planning and implementing any digital transformation projects, it is essential first to make sure that the enterprise itself is ready to uptake innovations and its environment also meets the stated goals and objectives.

### **Purpose**

All of the above enabled defining the *goal of this study*: the development of theoretical and methodological provisions for strategizing the digital transformation of economic systems that determine their propensity for transformation and form the priority directions of advanced development.

Achievement of this goal provides for the solution of the following tasks:

- analysis of modern scientific literature on the subject of research;

- development of a conceptual model of the digital twin of the regional economic system with the institutionalization of indices (measurable indicators) that objectively reflect the state of its economic processes;
- assessment of readiness of the regional economy to create a favorable business environment for enterprises at the stage of digital transformation and preparing standard recommendations for them on developing an IT architecture to be the background of business management in a digital economy.

*The object of the research* is the socio-economic system of the constituent entity of the Russian Federation. *The subject of the research* is the processes of strategizing the digital transformation of economic systems.

The study is carried out on the example of St. Petersburg, which is of great strategic importance for the industrial and innovative development of both the Northwestern Federal District, in particular, and the Russian Federation as a whole.

### Methodology

The relevance of studying the problems associated with the digitalization of the economy and its impact on the growth of social welfare, the importance of developing the theoretical and methodological foundations of change management, the role and significance of process innovations are noted by Russian (L.M. Borshch [15], T.V. Kramin [16], N.M. Rumyantsev [17], A.I. Tatarkin [18]) and foreign authors (J. Fagerberg [19], D. Kucera [20], R. Pradhan [21]). Concerning the development of strategic directions for the advanced development of socio-economic systems, the empirical basis of this study is the work of V.L. Kvint, who summarized the rules of strategic thinking and founded the Russian scientific school of theory of strategy, methodology, and strategizing practice. The basic postulate of the modern theory of strategy states that the availability of strategy is not really as important as its support with the relevant resources in all priority areas (development plants) [22].

The study of the works of these researchers leads to the conclusion that the readiness of the regional economy for transformation is determined by the consistency of the underlying systemic economic processes (development of transport and telecommunications infrastructure; the level of social support for the population; the number and quality of the economically active population; regulatory and legal support for business, the ability of enterprises to perceive innovations, etc.), and most importantly, the presence of a strategy presuming logically arranged and justified activities, synchronized in time and available resources. This postulate is a principle for all program documents, from the regional development strategy to the micro-enterprise strategy.

According to the world [23, 24] and domestic [25, 26] practice, for the formation of a strategy adequate to the goals and objectives of digital transformation, special tools are required that can identify and propose challenging schemes of advanced development for the need of accelerated digitalization of the economy. Such a toolkit may include an intelligent software package (strategist's office), the functionality of which would be sufficient to build a model (digital twin) of the region, considering its institutional, resource, social, technological, and other conditions. With the help of such a digital twin, by conducting experiments on it, mechanisms for triggering economic growth can be determined and justified for each specific regional economic system.

A regional economic system, like any other complex object, consists of a certain set of interacting processes, each of which can be formalized employing a mathematical function ( $f_i$ ) (Fig. 1). The set of local functions  $f_i$  is the digital twin ( $F$ ) of the system under study.

Input data are resources (factors  $x_i$ ), the transformation of which in the process of implementation leads to a change in the target state of the regional economic system (an increase in the share of innovative products in GRP, in the number of jobs, in value added, etc.). The change in the target state is monitored through the corresponding indicators  $y_i$ .

Parametric analysis of  $X$  and  $Y$  dependencies enables the formation of relationships between factor ( $X$ ) and indicator ( $Y$ ), reflecting the nature of the studied processes. By feeding the set values  $X_i$  to the input of the digital twin, the predicted results  $Y_i$  can be obtained at the output. When the parameters of the “digital twin” change, there is an opportunity to set goals and predict the course of a certain economic process, thus the strategizing is implemented.

The regional economic system can be generally characterized by several systemic economic processes; institutionalization allows identifying measurable development goals of the constituent entity of the Russian Federation and establish the relationship between controlled factors<sup>1</sup> and indicators<sup>2</sup> (Table 1).

**Table 1. List and characteristics of systemic economic processes that form the basis of the region’s economy**

Economic process	Brief summary
1. Institutional environment	– determines the quality of work of the public administration institutions system, represented by the effective formation of the gross regional product
2. Basic education, Healthcare, Social protection	– evaluates the effectiveness of education management, quality, and comfort of the life of the population as the basis of its professional, labor, and reproductive potential
3. Transport infrastructure	– reflects the quality of spatial planning and the achieved logistic connectivity of the region as an effective system for the transfer of goods, works, production forces, and services
4. Microeconomic environment consistency	– characterizes the features of the current state of the region’s economy in terms of budget balance, reflects the financial potential of the regional government, guarantees the provision of state and municipal services, and, in general, forms the image characteristics of the region, the business climate, and attractiveness for business
5. Labor market efficiency	– distinguishes the attractiveness of labor activity in the region and assesses its potential as a center of attraction for qualified labor resources
6. Financial market	– reflects the nature of consumer behavior of the active part of the population according to its focus and ability to good independent investment development
7. Higher education and advanced training	– reflects the region’s ability to create high-tech industries and attract qualified labor resources
8. Technological development	– determines the readiness of the economy for the innovations conversion, the modernization of existing technologies, and the introduction of new ones, that is, the readiness of subjects of economic activity to realize commercial, organizational, personnel, production, technical, and innovative potentials
9. Interregional trade	– characterizes the region’s capability to increase and scale up sales and consumption markets by increasing labor productivity
10. Innovative capacity	– reflects the region’s ability to create and commercialize new technologies and industries, expand the range of products, goods and services

Source: Authors

To describe the mathematical dependence, a paired linear approximation of the dependence of indicators ( $Y$ ) on controllable factors ( $X$ ) was used with an additive consideration of the random component. Economic analysis of processes is carried out using multi-composition “factor-indicator” couples, where factor ( $X$ ) is an indicator directly controlled by regional authorities, and indicator ( $Y$ ) shows mainly the macroeconomic quality and the process dynamics, such as growth or decline in labor productivity in the region, the dynamics of the gross regional product, or the budget income index [27].

The constructed model of the regional economic system allows differentiating the possibilities of economic growth by the contributions of the individual processes into the total value, identifying and tracking both long-term and short-term changes. In practice, the modeling processes are implemented using spe-

<sup>1</sup> A factor is a controllable parameter, the change of which leads to the achievement of the strategic goals of the region.

<sup>2</sup> An indicator is a resulting parameter that reflects changes in the economic process due to a change in the related factor.

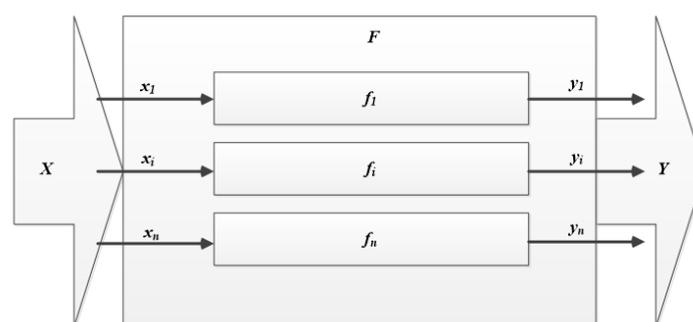


Fig. 1. Model of the regional economic system

Source: Authors

cial software “Forecasting and analytical system for strategizing the socio-economic development of the subjects of the Russian Federation” [28].

### Results

Calculations proved the correctness of the processes proposed for describing the regional economic system, based on the official data of the Federal State Statistics Service for 2007–2019 (see Table 1). To determine the consistency of the economic processes under consideration, an algorithm was used to assess the list of threshold values of the main standard indicators of correlation and regression analysis, which characterizes the accuracy and statistical validity of the applied approximations of the “factor-indicator” dependence. The calculation results for St. Petersburg are presented in Table 2.

In general, a comprehensive analysis of all processes that make up the basis of the socio-economic system of St. Petersburg (Fig. 2) leads to a conclusion about its orderly and systematic development, the capability to provide a favorable business climate for those business entities that plan to start the digital business transformation.

The calculations prove that the overwhelming number of processes that make up the basis of the economy of St. Petersburg is ahead of the average level of similar processes development in the constituent entities of the Russian Federation included in the North-West Federal District.

This state of affairs testifies to the extremely high degree of readiness of the regional economic entities to start mastering the existing innovative development potential (in particular, the process “Technological development” is 39% ahead of the average level in the federal district, the process “Innovative capacity” is 141%, and “Transport infrastructure” is 34% respectively). At the same time, such state of affairs obviously has a downside, since, with an unfavorable development of the situation (economic crisis and/or worsening of the epidemiological situation), the macroeconomic indicators of the region may tend to decrease due to changes in consumer preferences, the outflow of qualified personnel and a decrease in investment necessary to support the continuity of innovatization.

To reduce the mentioned risks, regional technological enterprises in a crisis and post-crisis situation should become the conductors of digital technologies for small and medium businesses which experience certain difficulties in acquiring and mastering innovations, also because of their high initial cost threshold. In other words, leading regional enterprises must take on the leadership of introducing and testing digital technologies, going through all stages of digital transformation, and thereby preparing a bridgehead in the region for large-scale digitalization of the economy. They should become an example and technologies contributor for supporting small and medium-sized enterprises, which can significantly increase their efficiency by reducing transaction costs and introducing modern technologies and management methods. It

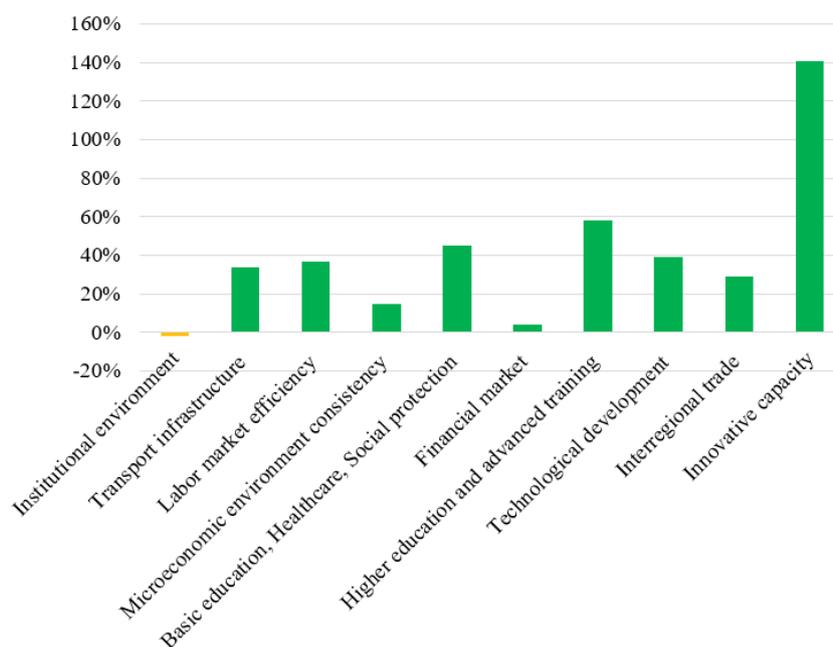


Fig. 2. Development indices of system processes in St. Petersburg relative to the average level of the constituent entities of the Russian Federation included in the North-West Federal District

Source: Authors

is necessary to start small, applying the available positive experience of digital transformation, using proven methods and technologies [29].

Among processes that are the most indicative and specifying the state and capabilities of the regional economic system of St. Petersburg, speaking about the implementation of professional competencies of the active part of the population regarding their applications for the sustainable advanced development of the territory, “Higher education and advanced training” and “Innovative capacity” are selected. These processes are decisive in terms of the formation and motivation of citizens capable of perceiving innovations and acquiring additional (digital) competencies necessary for the implementation of digital transformation procedures for both industrial and social relations.

#### 1. “Higher education and advanced training”

Factor  $X$  is the share of spending on technological innovation, determined by the ratio of annual expenditures on technological innovations to the annual volume of investments in the capital stock. Factor management is formed by the need to attract a highly qualified workforce for the development of new jobs required from certain digital competencies.

Indicator  $Y$  means the number of employed people with higher education per 10 employees.

The process under consideration, along with the “Labor market efficiency”, represents a kind of employment adjustment.

The estimated parameters of the process are shown in Fig. 3.

Analysis of the diagram from Fig. 2 demonstrates that the end of 2019 in St. Petersburg was marked by a significant increase in the share of technological innovation spending (for example, by 20% in comparison to 2017). At the same time, there was a decline in the number of employed personnel with higher education by 2.5% (out of 10 employees). This situation suggests that enterprises producing innovative goods and services experienced a decrease in operating costs and an increase in added value (a significant role belonged to the competence of employees and labor productivity). This indicates that the situation is

under control despite the depreciation of the ruble, and the import substitution program is being successfully implemented.

**Table 2. Data on the assessment of the consistency of economic processes that simulate the socio-economic system of St. Petersburg**

Economic process	Factor, $X$	Indicator, $Y$	Correlation coefficient, $R_{xy}$	Approximation error, $E_r$
<i>Basic economic processes</i>				
Institutional environment	Regional Public administration Cost Index	GRP formation efficiency index	0.77	2.61
Basic education, Healthcare, Social protection	Regional budget spending index for the social block	Standard index of gross regional product	0.72	4.08
Transport infrastructure	Density of public hard surface road	Standard index of gross regional product	0.56	2.10
Microeconomic environment consistency	Regional budget gross spending index	Regional budget gross income index	0.97	3.14
Labor market efficiency	Index of regional budget expenditures on the national economy	Average wage index	0.73	3.37
Financial market	Share of regional budget expenditures under the national economy item	Credit exposure index of employed individuals	0.80	14.20
<i>Economic processes of advanced development</i>				
Higher education and advanced training	Share of spending on technological innovations	Number of employees with higher education per 10 employees	0.72	3.14
Technological development	Share of costs for information and communication technologies in total investment into capital stock	The ratio of the produced GRP to the volume of total (annual) investments into capital stock	0.86	8.02
Interregional trade	Foreign trade turnover index	Average annual foreign exchange labor productivity index	0.90	6.17
Innovative capacity	Technological innovations cost index	The share of innovative products, works, services	0.96	15.24

## 2. “Innovative capacity”

Factor  $X$  is the cost index for technological innovation, which is the ratio of the cost of technological innovation to the average annual number of employed citizens, modified to the average annual US dollar exchange rate. Factor  $X$  characterizes the investment activity of all regional economic entities in terms of implementation of technological innovations, directly or indirectly stimulated by the regional authorities. Indicator  $Y$  shows the share of goods, works, and services produced in % of the total volume of goods shipped, works performed, services rendered in the region for a calendar year.

The process under consideration, along with “Technological development”, is significant in terms of the formation of structural shifts in the economy, which determine the opportunities and capabilities of the overwhelming majority of economic entities for digital transformation.

The estimated parameters of the process are shown in Fig. 4.

Model visualization confirms that considered economic processes in St. Petersburg are valid from the viewpoint of the correctness of the formalization of the indices used to describe them. If necessary, to further analyze the influence of the components of factor  $X$  on the result of process  $Y$ , indicators can be detailed to develop the most appropriate management decisions (activities).

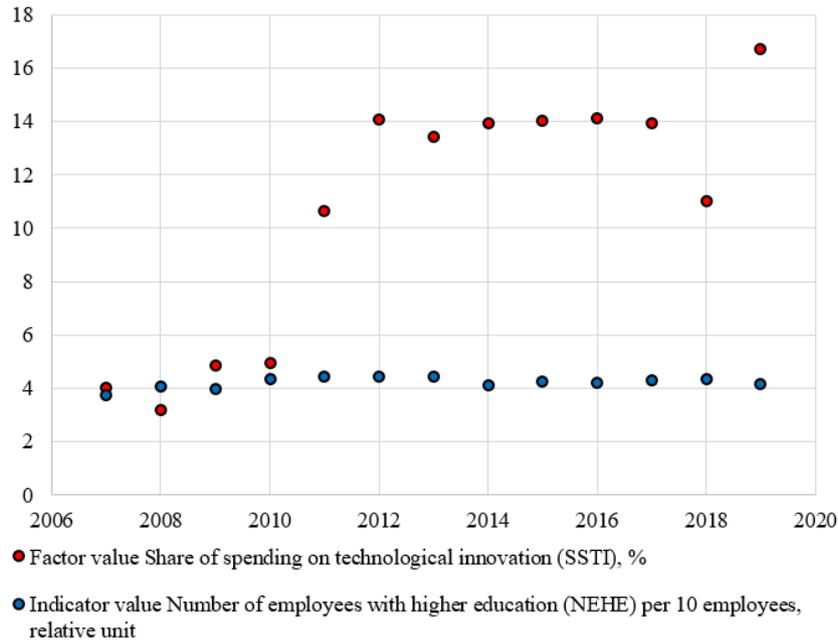


Fig. 3. Change in the controlled factor  $X$  and the resulting indicator  $Y$  in the period under review from 2007 to 2019  
 Source: Authors

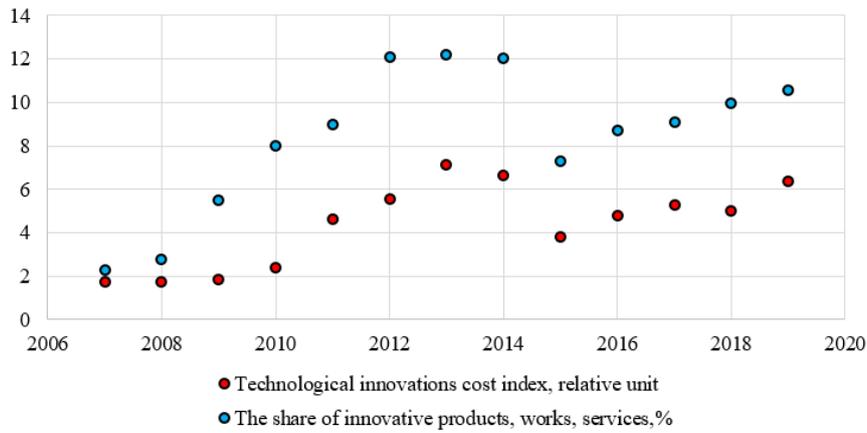


Fig. 4. Change in the controlled factor  $X$  and the resulting indicator  $Y$  in the period under review from 2007 to 2019  
 Source: Authors

In general, the results obtained are consistent with the main directions of the advanced development of the city, enshrined in a regulatory document – the Strategy of Social and Economic Development of St. Petersburg up to 2035, approved by the Law No. 771-164 of St. Petersburg dated December 19, 2018 (as amended on November 26, 2020), which defines goals and priorities, as well as formed indicators characterizing the degree of their achievement. The main factors that ensure the innovation of the region are: stimulation of the production of high-tech products and services, the growth of investment in human capital, and the digital transformation of the economy. Development based on the principles of digitalization of the economy is recognized as decisive in all spheres of socio-economic activity, increasing competitiveness and ensuring progressive economic growth.

Nevertheless, using the methodological approaches proposed in this article for a retrospective assessment of the macroeconomic state of the city of St. Petersburg allows a more reasonable proposition of a system of priority long-term targets. Although assessment of the quality of the current strategy is not the purpose of this study, based on the results of an extended and detailed analysis, certain recommendations can be issued on goal-setting and clarification of the priority directions of the city's development.

### Discussion

One of the practical recommendations, useful for enterprises in the real sector of the economy planning to carry out the digital business transformation, is the creation of a digital IT ecosystem (digital platform), which performs the key function in successful transformations. Working with a digital platform is a recognized trend at the current stage of engineering, technology, and industrial and economic relations development. It seems that all business processes of the production life cycle, without exception, should be implemented using digital data and digital infrastructure in a unified information space (Fig. 5).

A technologically unified information space of an enterprise can be defined as a set of integrated applications that comprehensively support all the main business processes of operating and commercial activities, accounting procedures, customer relationship management, planning and forecasting, budgeting, management of regulatory and reference information, and also provide data exchange between all services.

The connecting link of the applications is the corporate process and content management system, which in the target functional IT ecosystem is positioned as a single window to the catalog of "internal services" of the enterprise, as well as as a tool for the operational work of managers and personnel when performing daily routine operations and assignments. In fact, this is an umbrella system, for it covers all the needs for obtaining and processing information essential for making decisions from the level of the general director to the personnel of the shop (branch), and is built-up on the principles of continuity of management and information processes.

Fig. 6 schematically shows a model of economic effects in the digital transformation of an enterprise, technologically based on the IT ecosystem, the integrating link of which is the corporate process and content management system.

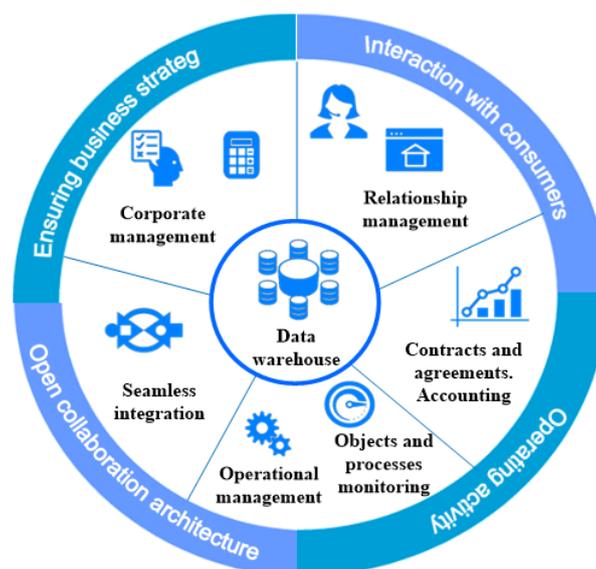


Fig. 5. Unified information space of a digital enterprise

Source: Authors

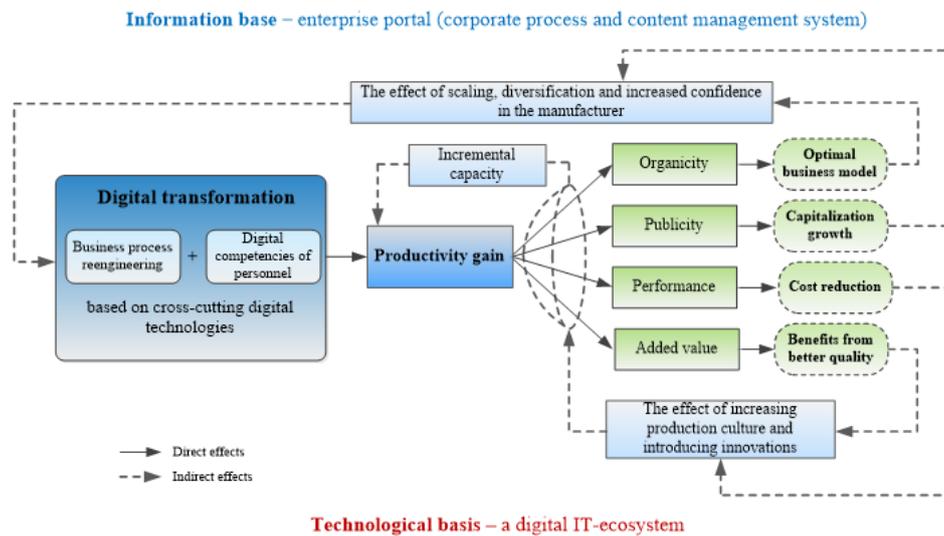


Fig. 6. Model of economic effects in digital transformation  
Source: Authors

The key point that determines the success of the digital transformation is the ability of top management, following the developed strategy, to ensure an effective combination of employee competencies with innovative technologies in the process of transforming the production life cycle. In other words, the digital transformation strategy requires the designing of a separate, maximally detailed program for the creation and development of human resources (target motivation, advanced training of elder personnel, acceptance of the values of corporate culture, etc.). In this regard, it is necessary to separately note the change in the behavior patterns of the most active part of the population aged 20 to 35 years, where often, thanks to developed communications and the possibility of obtaining information, consumer values are re-estimated. For example, the opportunity to gain practical experience and build a positive resume for subsequent career growth may outweigh the value of the current material reward. Such trends in the formation of an active innovative style and susceptibility to constant changes should be monitored in the labor market, first of all, to attract talent. They should become one of the key factors in attracting capable young people to implement a long-term development strategy at the corporate and regional levels.

### Conclusion

1. The applied model of the socio-economic system of a constituent entity of the Russian Federation is proposed for carrying out a systematic analysis of its macroeconomic indicators, which is necessary, firstly, to conduct a comprehensive assessment of the regions readiness for transformations towards the digitalization of the economy, and secondly, for reasonable goal-setting and determination priority areas of development for strategizing.

2. The example of St. Petersburg city shows that the decisive role in the process of the digital transformation of business should be taken by city-forming enterprises that have the appropriate infrastructure and the necessary resources, primarily qualified personnel.

3. The basis of the planned transformations of economic systems are IT ecosystems (digital platforms) that realize an integrated approach to management decisions using knowledge economy technologies such as predictive analytics, artificial intelligence, big data, cloud computing, etc. The best management decisions may only be taken, if the persons who undertake them and participate in the preparation have access to verified, relevant and structured information from reliable independent sources.

4. The main component of a digital transformation solution is a strategy, the completeness, quality, validity, and adequacy of which determines the effectiveness and success of not only the planned transformations, but the entire work as a whole. An enterprise digital transformation strategy should include full-scale marketing research, analysis of the external and internal environment, a list of planned and promising end-to-end technologies. Moreover, all this should be formalized in interconnected complex digitalization programs, synchronized in time and resources.

#### Directions for further research

The present article considers a reduced model of the socio-economic system of the region, which includes ten basic processes. When moving to the practical implementation of the proposed approach, for a more accurate assessment and development of recommendations on the choice of areas of advanced development (development of strategic priorities) for a specific region, the structure of the digital twin should be detailed. Therefore, further research will be associated with the selection and formalization of an additional set of “factor-indicator” couples. At the same time, for justifying the feasibility and effectiveness of the procedures for the digital transformation of economic systems, certain measures will be devoted to developing appropriate methods.

#### Acknowledgments

The reported study was funded by RFBR, project number 20-010-00942 A.

#### REFERENCES

1. The country's transition to renewable energy sources threatens Russian energy companies. URL: <https://www.kommersant.ru/doc/4663944> (accessed February 01, 2021).
2. **V.A. Mau**, At the final stage of the global crisis: Economic tasks in 2017–2019. *Voprosy Ekonomiki*, 2018, no. 3, pp. 5–29. (rus). DOI: 10.32609/0042-8736-2018-3-5-29
3. **K. Schwab**, *The Fourth Industrial Revolution*. Penguin. London. 2017. 192 p.
4. **Yu.M. Osipov, T.N. Yudina, I.G. Geliskhanov**, Information-Digital Economy: Concept, Basic Parameters and Implementation Mechanisms. *The Moscow University Economics Bulletin*, 2019, no. 3, pp. 41–60. (rus)
5. **A.V. Vorontsovskiy**, Digitalization of the economy and its impact on economic development and social welfare. *St Petersburg University Journal of Economic Studies*, 2020, vol. 36, no. 2, pp. 189–216. (rus). DOI: 10.21638/spbu05.2020.202
6. **V.K. Chaadaev**, «Smart housing and communal services» as cost reduction in the management of apartment buildings. In the collection: *Economics and management of the national economy: genesis, current state and development prospects*. Materials of the II International Scientific and Practical Conference. In 2 parts, 2018, pp. 211–215. (rus)
7. **M.Yu. Arkhipova, V.P. Sirotin**, Development of digital technologies in Russia: regional aspects. *Economy of Region*, 2019, vol. 15, no. 3, pp. 670–683. (rus)
8. **L.G. Matveeva, A.Yu. Nikitaeva, O.A. Chernova**, Information as a strategic resource for regional development: institutional and technological aspects. *Terra Economicus*, 2018, vol. 16, no. 1, pp. 134–145. (rus). DOI: 10.23683/2073-6606-2018-16-1-134-145
9. **I.V. Mitrofanova, M.A. Bisakaeva, N.R. Gukasova, A.A. Orlyanskaya**, Digital transformation of peripheral regions of the South of Russia (on the example of the Chechen Republic). *Economics: Yesterday, Today and Tomorrow*, 2018, vol. 8, no. 10A, pp. 117–131. (rus)
10. **A.A. Urasova, M.A. Mukhin, K.F. Kochina**, Topical approaches to managing socio-economic development of territories. *The Manager*, 2018, vol. 9, no. 1, pp. 14–23. (rus). DOI: 10.17059/2019-3-4
11. **V.V. Akberdina, A.V. Grebenkin, G.B. Korovin, A.I. Ponomareva**, Modelling of industrial policy on the basis of game-theoretic models of interaction between government and business. *Journal of Economic Theory*, 2018, vol. 15, no. 4, pp. 554–560. (rus). DOI: 10.31063/2073-6517/2018.15-4.1
12. **E.V. Balatsky, N.A. Ekimova**, Innovation-technology matrices and national economic development strategies. *Upravlenets – The Manager*, 2019b, vol. 10, no. 5, pp. 9–19. (rus). DOI: 10.29141/2218-5003-2019-10-5-2

13. **G.B. Korovin**, Architecture of the agent-based model for the region's industrial complex digital transformation. *Journal of New Economy*, 2020, vol. 21, no. 3, pp. 158–174. (rus). DOI: 10.29141/2658-5081-2020-21-3-8
14. **I.V. Novikova**, Concept of Employment Strategy for the Digital Economy. Kemerovo, Kemerovo State University, 2020, 254 p. (rus)
15. **L.M. Borshch, S.V. Gerasimova**, Spatial model of innovative technological regional development. *St. Petersburg State Polytechnical University Journal. Economics*, 2018, vol. 11, no. 4, pp. 185–199. (rus). DOI: 10.18721/JE.11414
16. **T.V. Kramin, A.R. Klimanova**, Development of digital infrastructure in the Russian regions. *Terra Economicus*, 2019, no. 17(2), pp. 60–76. (rus). DOI: 10.23683/2073-6606-2019-17-2-60-76
17. **N.M. Rumyantsev, E.G. Leonidova**, Asymmetry problems of structural shifts in regional economy. *Economic and Social Changes: Facts, Trends, Forecast*, 2020, vol. 13, no. 6, pp. 169–183. (rus). DOI: 10.15838/esc.2020.6.72.10
18. **A.I. Tatarkin**, Regional Targeting of the Economic Policy of the Russian Federation as an Institution of Regional Spatial Development. *Economy of Region*, 2016, vol. 12, no. 1, pp. 9–27. (rus). DOI: 10.17059/2016-1-1
19. **J. Fagerberg**, Technological progress, structural change and productivity growth: a comparative study. *Structural Change and Economic Dynamics*, 2000, vol. 11, no. 4, pp. 393–411. DOI: 10.1016/S0954-349X(00)00025-4
20. **D. Kucera, X. Jiang**, Structural transformation in emerging economies: leading sectors and the balanced growth hypothesis. *Oxford Development Studies*, 2019, vol. 47, pp. 188–204. DOI: 10.1080/13600818.2018.1533934
21. **R.P. Pradhan, G. Mallik, T.P. Bagchi**, Information communication technology (ICT) infrastructure and economic growth: A causality evinced by cross-country panel data // *IIMB Management Review*, 2018, no. 30 (1), pp. 91–103. DOI: 10.1016/j.iimb.2018.01.001
22. **V.L. Kvint**, Strategy concept. Kemerovo, Kemerovo State University, 2020, 170 p. (rus)
23. **A. Beer, S. Ayres, T. Clower, F. Faller, A. Sancino, M. Sotarauta**, Place leadership and regional economic development: a framework for cross-regional analysis. *Regional Studies*, 2019, vol. 53, no. 2, pp. 171–182. DOI: 10.1080/00343404.2018.1447662
24. **R.M. Samaniego, J.Y. Sun**, Productivity growth and structural transformation. *Review of Economic Dynamics*, 2016, vol. 21, pp. 266–285. DOI: 10.1016/j.red.2015.06.003
25. **N.V. Smorodinskaya, D.D. Katukov**, When and why regional clusters become basic building blocks of modern economy. *Baltic region*, 2019, vol. 11, no. 3, pp. 61–91. (rus). DOI: 10.5922/2079-8555-2019-3-4
26. **A.G. Aganbegyan**, Analysis and forecasting of socio-economic development of regions (methodical notes). *Central Russian Journal of Social Sciences*, 2019, vol. 14, no. 4, pp. 15–28. (rus). DOI: 10.22394/2071-2367-2019-14-4-15-28
27. **D.M. Zhuravlev**, Development of a model of the regional economic system of the constituent entity of the Russian Federation. *MIR (Modernization. Innovation. Research)*, 2020, vol. 11, no. 1, pp. 29–43. (rus). DOI: 10.18184/2079-4665.2020.11.1.29-43
28. Forecasting and analytical system of strategizing the socio-economic development of the constituent entities of the Russian Federation. Certificate of state registration of the computer program No. 2020612044. URL: [https://new.fips.ru/registers-doc-view/fips\\_servlet?DB=EVM&rn=4095&DocNumber=2020612044&TypeFile=html](https://new.fips.ru/registers-doc-view/fips_servlet?DB=EVM&rn=4095&DocNumber=2020612044&TypeFile=html) (accessed February 04, 2021).
29. **V.N. Pinchuk, D.M. Zhuravlev**, Company. Technologies and economics of digital transformation. Novosibirsk, Akademizdat, 2020, 216 p. (rus)

## СПИСОК ЛИТЕРАТУРЫ

1. The country's transition to renewable energy sources threatens Russian energy companies. URL: <https://www.kommersant.ru/doc/4663944> (accessed February 01, 2021).
2. **May B.A.** На исходе глобального кризиса: экономические задачи 2017–2019 гг. *Вопросы экономики*. 2018; (3): 5–29. <https://doi.org/10.32609/0042-8736-2018-3-5-29>.
3. **Schwab K.** *The Fourth Industrial Revolution*. Penguin. London. 2017. 192 p.

4. **Осипов Ю.М., Юдина Т.М., Гелисханов И.З.** Информационно-цифровая экономика: концепт, основные параметры и механизмы реализации. Вестник московского университета. Серия 6: Экономика. 2019; (3): 41–60.
5. **Vorontsovskiy A.V.** Digitalization of the economy and its impact on economic development and social welfare. St Petersburg University Journal of Economic Studie. 2020; 36 (2): 189–216. (rus). <https://doi.org/10.21638/spbu05.2020.202>.
6. **Чадаев В.К.** «Умное ЖКХ» как сокращение издержек в управлении многоквартирными домами. Экономика и управление народным хозяйством: генезис, современное состояние и перспективы развития. Материалы II Международной научно-практической конференции. В 2-х частях. 2018; 211–215.
7. **Архипова М.Ю., Сиротин В.П.** Региональные аспекты развития информационнокоммуникационных и цифровых технологий в России. Экономика региона. 2019; 15 (3): 670–683.
8. **Matveeva L.G., Nikitaeva A.Yu., Chernova O.A.** Information as a strategic resource for regional development: institutional and technological aspects. Terra Economicus, 2018; 16 (1): 134–145. (rus). <https://doi.org/10.23683/2073-6606-2018-16-1-134-145>.
9. **Митрофанова И.В., Бисакаева М.А., Гукасова Н.Р., Орлянская А.А.** Цифровая трансформация периферийных регионов Юга России (на примере Чеченской Республики). Экономика: вчера, сегодня, завтра. 2018; 8 (10А): 17–131.
10. **Урасова А.А., Мухин М.А., Кочина К.Ф.** Актуальные подходы к управлению социально-экономическим развитием территории. Управленец, 2018; 9 (1): 14–23. <https://doi.org/10.291-41/2218-5003-2018-9-1-3>.
11. **Акбердина В.В., Гребенкин А.В., Коровин Г.Б., Пономарева А.И.** Моделирование промышленной политики на основе теоретико-игровой модели взаимодействия государства и бизнеса. Журнал Экономической теории, 2018; 15 (4): 554–560. <https://doi.org/10.31063/2073-65-17/20-18.15-4.1>.
12. **Балацкий Е.В., Екимова Н.А.** Инновационно-технологические матрицы и национальные стратегии экономического развития. Управленец, 2019; 10 (5): 9–19. <https://doi.org/10.291-41/2218-5003-2019-10-5-2>.
13. **Korovin G.V.** Architecture of the agent-based model for the region's industrial complex digital transformation. Journal of New Economy, 2020; 21 (3): 158–174. (rus). <https://doi.org/10.29141/2658-5081-2020-21-3-8>.
14. **Новикова И.В.** Концепция стратегии занятости населения в цифровой экономике. Кемерово, Кемеровский государственный университет, 2020, 254 с.
15. **Борщ Л.М., Герасимова С.В.** Пространственная модель инновационного технологического регионального развития. Научно-технические ведомости СПбГПУ. Экономические науки, 2018; 11 (4): 185–199. <https://doi.org/10.18721/ЖЕ.11414>.
16. **Крамин Т.В., Климанова А.Р.** Развитие цифровой инфраструктуры в регионах России. Terra Economicus, 2019; 17 (2), 60–76. DOI: 10.23683/2073-6606-2019-17-2-60-76
17. **Rumyantsev N.M., Leonidova E.G.** Asymmetry problems of structural shifts in regional economy. Economic and Social Changes: Facts, Trends, Forecast, 2020; 13(6): 169–183. (rus). <https://doi.org/10.15838/esc.2020.6.72.10>.
18. **Tatarkin A.I.** Regional Targeting of the Economic Policy of the Russian Federation as an Institution of Regional Spatial Development. Economy of Region, 2016; 12 (1): 9–27. (rus). <https://doi.org/10.17059/2016-1-1>.
19. **Fagerberg J.** Technological progress, structural change and productivity growth: a comparative study. Structural Change and Economic Dynamics, 2000; 11 (4): 393–411. [https://doi.org/10.1016/S0954-349X\(00\)00025-4](https://doi.org/10.1016/S0954-349X(00)00025-4).
20. **Kucera D., Jiang X.** Structural transformation in emerging economies: leading sectors and the balanced growth hypothesis. Oxford Development Studies, 2019; 47: 188–204. <https://doi.org/10.1080/13600818.2018.1533934>.
21. **Pradhan R.P., Mallik G., Bagchi T.P.** Information communication technology (ICT) infrastructure and economic growth: A causality evinced by cross-country panel data. IIMB Management Review, 2018; 30 (1): 91–103. <https://doi.org/10.1016/j.iimb.2018.01.001>.
22. **Квинт В.Л.** Концепция стратегирования: монография. Кемерово: Кемеровский государственный университет, 2020. 170 с. ISBN: 978-5-8353-2562-7.



23. Beer A., Ayres S., Clower T., Faller F., Sancino A., Sotarauta M. Place leadership and regional economic development: a framework for cross-regional analysis. *Regional Studies*, 2019; 53 (2): 171–182. <https://doi.org/10.1080/00343404.2018.1447662>.

24. Samaniego R.M., Sun J.Y. Productivity growth and structural transformation. *Review of Economic Dynamics*, 2016; 21: 266–285. <https://doi.org/10.1016/j.red.2015.06.003>.

25. Смородинская Н.В., Катуков Д.Д. Когда и почему региональные кластеры становятся базовым звеном современной экономики. *Балтийский регион*, 2019; 11 (3): 61–91. <https://doi.org/10.5922/2079-8555-2019-3-4>.

26. Аганбегян А.Г. Анализ и прогнозирование социально-экономического развития регионов (методические заметки). *Среднерусский вестник общественных наук*, 2019; 14 (4): 15–28. <https://doi.org/10.22394/2071-2367-2019-14-4-15-28>.

27. Журавлев Д.М. Разработка модели региональной экономической системы субъекта Российской Федерации. *МИР (Модернизация. Инновации. Развитие)*. 2020; 11 (1): 29–43. <https://doi.org/10.18184/2079-4665.2020.11.1.29-43>.

28. Forecasting and analytical system of strategizing the socio-economic development of the constituent entities of the Russian Federation. Certificate of state registration of the computer program No. 2020612044. URL: [https://new.fips.ru/registers-doc-view/fips\\_servlet?DB=EVM&rn=4095&-DocNumber=2020612044&TypeFile=html](https://new.fips.ru/registers-doc-view/fips_servlet?DB=EVM&rn=4095&-DocNumber=2020612044&TypeFile=html) (accessed February 04, 2021).

29. Пинчук В.Н., Журавлев Д.М. *Предприятие. Технологии и экономика цифровой трансформации*. Новосибирск: ИД Академиздат, 2020. 216 с. ISBN: 978-5-6045107-3-5.

*Статья поступила в редакцию 01.03.2021.*

#### СВЕДЕНИЯ ОБ АВТОРАХ / THE AUTHORS

**ЖУРАВЛЕВ Денис Максимович**

E-mail: [jdenis@niiss.ru](mailto:jdenis@niiss.ru)

**ZHURAVLEV Denis M.**

E-mail: [jdenis@niiss.ru](mailto:jdenis@niiss.ru)

**ГЛУХОВ Владимир Викторович**

E-mail: [office.vicerecator.me@spbstu.ru](mailto:office.vicerecator.me@spbstu.ru)

**GLUKHOV Vladimir V.**

E-mail: [office.vicerecator.me@spbstu.ru](mailto:office.vicerecator.me@spbstu.ru)