European Proceedings of
Social and Behavioural Sciences
EpSBS
www.europeanproceedings.com
e-ISSN: 2357-1330

DOI: 10.15405/epsbs.2021.04.55

CDSES 2020
IV International Scientific Conference "Competitiveness and the development of socio-economic systems" dedicated to the memory of Alexander Tatarkin

MANUFACTURING INDUSTRY MODERNIZATION AS THE BASIS FOR DIGITALIZATION OF THE ECONOMY

Julia Dubrovskaya (a)*, Elena Kozonogova (b), Juliana Tarasova (c)
*Corresponding author

(a) Perm National Research Polytechnic University, 29, Komsomolsky St., Perm, Russia, uliadubrov@mail.ru
(b) Perm National Research Polytechnic University, 29, Komsomolsky St., Perm, Russia, elena.kozonogova@gmail.com
(c) Perm National Research Polytechnic University, 29, Komsomolsky St., Perm, Russia, tar.yulya2013@yandex.ru

Abstract

The study's purpose is a theoretical and practical substantiation of the technological modernization importance for the industrial sector of the national economy in the light of digitalization. The unreadiness of the national economy for Industry 4.0, due to the Industry 3.0 stage's incompleteness, is substantiated. In particular, it is due to a high degree of depreciation of fixed assets in the manufacturing industry. Because digital tools are adapted for innovative equipment, full-scale digitalization creates a threat of lagging for countries that have not undergone equipment modernization. To assess the impact of technological modernization of the industrial sector on the level of digital development of territories, the authors built an ordered logit model based on data from 85 regions of Russia for 2017. As an endogenous variable, we used the digital development levels of Russian regions obtained by clustering territories using Ward's method. The clustering was based on the calculation of the International Digital Economic and Society Index for Russia's regions. The results obtained during the modeling are consistent with the theoretical provisions of the neoclassical model of economic growth by Solow and prove the high impact of modernization of the manufacturing industry on the level of digital development of territories, which determines the prospects for the transition of the national economy to Industry 4.0.

Keywords: Digitalization, manufacturing industry, ordered logit model, regional economy, smart benchmarking

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

1. Introduction

The digital revolution and the emergence of Industry 4.0 have led to the transition to a neo-industrial model of economic development, the main prerequisite for implementing the full-scale introduction of "smart production". This means the integration of digital technologies into production processes based on "smart machines", as well as the creation of information platforms to manage the entire product life cycle. As a rule, Industry 4.0 is mentioned in the context of industry computerization based on the introduction of cyber-physical systems. In such a system, sensors, equipment, and information systems are connected throughout the entire value chain, extending beyond a single enterprise or business.

At the same time, having a significant impact on the rate of economic growth (Akinwale et al., 2019; Zhou & Luo, 2018) digital and technological innovations cannot be identified within the framework of the traditional classification of factors in terms of territorial development, produced at the end of the twentieth century by Krugman (1993), the founder of new economic geography, Nobel laureate of 2008. It is about dividing the entire set of competitive advantages of territories into factors of the first and second nature.

In this case the factors of the "first nature" that exist independently of human activities include the provision of natural resources, geographical location, including the border position on the routes of global trade, which reduces transport costs. The factors of the "second nature" are the advantages created by the activities of man and society: the agglomeration effect, human capital, institutions contributing to the improvement of the business climate, population mobility, the diffusion of innovations, etc. It is known that the presence of factors of the first nature and the development of factors from the second nature group is the cause of heterogeneous socio-economic development, which often leads to divergence of territories. This is especially true for countries with large territories like Russia. As it was noted by Barinova & Zemtsov (2020, p. 10) "Russia's large territory and the mix of natural and economic conditions predetermine strong regional differentiation".

In accordance with the meaningful characteristics belonging to the two groups of development factors, digitalization cannot be attributed to either of them. In this case, digitalization, like information, cannot be decreased in the process of being used by individuals (the principle of limited economic resources does not work). In this we see the dichotomous nature of the digitalization process as a factor in the development of the territory. Penetrating into all spheres of life and transforming all sectors of the economy, digitalization, on the one hand, provides all territories, regardless of their starting level of development, significant opportunities for economic growth. On the other hand, its absence at the present time can cause invaluable harm to any economy, even one rich in raw materials. Thus, an unforeseen negative consequence of the lack of digital work skills in individuals and the physical limitation of their access to the global network has led to the almost complete stop of educational processes in a number of peripheral schools during the pandemic Economists have long proven the high impact of human capital on economic growth, a decrease in which will be objectively recorded in peripheral territories not covered by digitalization (Mankiw et al., 1992).

Summing up the above, we emphasize that the phenomenon of digitalization simultaneously has a colossal potential for both stimulation and degradation of territorial development. Therefore, the mere existence of the advantages of the digital economy can both reduce spatial gaps in levels of development, and significantly increase them.

Digitalization issues in Russia have become an object of increased attention of both business and government authorities and the scientific community after the adoption of the program called "Digital Economy of the Russian Federation" by the Government of the Russian Federation on July 28, 2017. Influencing all areas of economic development, digital advantages are being studied by scientists in the field of agriculture (Shamin et al., 2020), financial system (Kiyutsevskaya, 2019), public services (Zhuk & Fursa, 2019), wholesale and retail trade (Kupriyanovsky et al., 2016). At the same time, scientists emphasize that the manufacturing sector has the main multiplier effect on economic growth (Inozemtsev, 2010).

Thus, the share of the manufacturing sector in the sectoral structure of Russia's GDP is equal to 12.8% (1st place) according to statistics for 2019. We believe that both the increase in the competitiveness of the national economy and, in general, the rate of economic growth of the country depend on the development of this sector.

At the same time, as it was noted by Urasova (2019), a significant slowdown in the development of industry in Russia is associated with the discrepancy between modern software and existing equipment at most enterprises and organizations. This conclusion seems to be objective and timely, and is confirmed by the official data of Rosstat on the degree of wear and tear of machinery and equipment in the national economy, which at the end of 2018 constituted 59.6% of the total volume of fixed assets1. Due to the fact that digital tools (RFID tags, ERP systems, cloud services, etc.) are adapted for innovative equipment, full-scale digitalization creates a threat of lagging behind countries (including Russia) that have not undergone equipment modernization.

Thus, the actual problem of full digitalization in the industry of the national economy is the fact that it is not ready for Industry 4.0.

2. Problem Statement

The objective of the study is to build an ordered logit model that allows interpreting the modeling results for an endogenous variable in the form of a rank scale. In this study, the ranking scale is represented by the digital development levels of Russian regions.

3. Research Questions

The main research issue is to quantify the likelihood of territories' transition to a higher level of digital development. This type of assessment is possible based on the analysis of the marginal effects of exogenous variables.

[1] Federal State Statistics Service of Russia. (2020, April 28). https://gks.ru/free_doc/new_site/business/osnfond/STIZN_ved.htm

4. Purpose of the Study

The aim of the study is to assess the impact of technological modernization in the industrial sector on the level of spatial digital development, which determines the prospects and opportunities for the transition of the national economy to Industry 4.0.

5. Research Methods

5.1. Research methodology

The International Digital Economy and Society Index (I-DESI) was chosen as an assessment tool for the digitalization level of the regions in the Russian Federation to conduct the empirical part of the study. I-DESI is developed on the basis of the DESI index for the member countries of the European Union and assesses the level of the economy and society digitalization both in individual countries of the European Union and the European Union as a whole.

I-DESI allows to develop adequate development directions and adjust the tools for implementing policy in the field of the digital economy and society. Therefore, in terms of content, I-DESI is suitable for assessing the readiness of Russian regions for the transition to a digital economy.

In general, I-DESI is built on the basis of five main parameters:

- Communication (the parameter evaluates the implementation of the broadband network infrastructure and its quality);
- Human capital (a parameter that measures the level of skills of the population required to take advantage of the digital society);
- Internet use (the indicator takes into account various types of activities in demand by the population on the Internet);
- Integration of digital technologies in business (it measures the digitalization of business and the use of remote sales channels, and also reflects the level of digitalization penetration into the industrial sector);
- Digital public services (the indicator reflects the scale of electronic services in the public sector, with the main focus made on the development of "electronic government" - e-Government).

An ordered logit model was built to assess the impact of technological modernization in the industrial sector on the level of spatial digital development, which determines the prospects and opportunities for the transition of the national economy to Industry 4.0. A model of this type is used when the endogenous variable is measured on a rank scale. At the same time, situations where the results of modeling in accordance with the meaningful meaning should be presented in a rank scale are quite common. So, for example, scientists solve the following research questions using the ordered logit model:

- whether the poorest income quintile would benefit most from programs aimed at increasing their access to financial services (Abraham, 2018);
- examination individual and contextual factors of happiness and life satisfaction in the happiest countries in the world (Sujarwoto et al., 2018);

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

- research of patients' propensity to consume private healthcare services (Meleddu et al., 2020).

The considered model has the following form:

$$y_i^* = x_i' \beta + \varepsilon_i ,$$

where x_i – a vector of explanatory variables, β – a vector of coefficients, ε_i– a random component distributed according to the normal law.

The variable y_i^* - itself is an unobservable value, which is related to the observed discrete variable value y_i by the following relations:

$$y_i = \begin{cases} 0, if\ y_i^* \leq 0 \\ 1, if\ 0 < y_i^* \leq \mu_1 \\ 2, if\ \mu_1 < y_i^* \leq \mu_2 \\ \dots \\ J, if\ \mu_{j-1} \leq y_i^* \end{cases}$$

where $\mu_1, \mu_2, \dots, \mu_{j-1}$ - threshold values, J – the number of possible ordered values.

Then the probability of a certain outcome can be obtained as follows:

$$\Pr(y_i = j | x_i) = F\left(\mu_{j+1} - x_i' \beta\right) - F\left(\mu_j - x_i' \beta\right).$$

The model parameters are estimated using the maximum likelihood method. The logarithmic likelihood function will have the following form:

$$\ln L\left(\beta, \mu_1, \dots, \mu_{j-1}, y, x\right) = \sum_{i=1}^{N} y_{ij} \ln \Pr\left(y_i = | x_i\right).$$

The ordered values of the level of spatial digital development were taken as an explained variable (1 is the lowest level of digital development, ... 5 is the highest level). The level of digital development is assigned to a territory based on the results of cluster analysis according to the regional development indicators of a digital society relevant to the I-DESI index, corresponding to 5 areas of research: communication, digital skills, use of the Internet by citizens, integration of business technologies, digital public services.

The selection of indicators for cluster analysis is based on the following requirements:

1. the requirement of representativeness, according to which the indicators should most fully reflect the relevant aspects of the regional development;
2. the requirement of accessibility, according to which the indicators involved in the analysis should be included in the list of official statistical indicators - either calculated from the values of the latter, or published in open sources of information. A prerequisite for choosing indicators is the availability of data for all regions within the relevant year. The use of averaged values based on previous periods instead of missing data is often used in this kind of research, but, in our opinion, this is undesirable, since the level of distortion of the results increases;
3. the requirement of objectivity, according to which the indicators used should adequately reflect the state of the analyzed aspect of the regional development. The use of indicators in other assessment methods was taken into account, as well as their inclusion in the number of indicators reflecting the effectiveness of the state policy implementation;
4. the requirement to take into account regional characteristics, according to which indicators reflecting factors that have the most significant impact on the life of the population and the region's development should be selected for assessment and forecasting.

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

Clustering for the purpose of dividing territories according to the level of digital development is carried out by implementing the following steps:

1. Determination of the set of variables by which the objects in the sample are estimated and the normalization of the variables values using a linear transformation:

$$y(x) = \frac{x - x_{min}}{x_{max} - x_{min}}$$

2. Calculation of the values of the similarity extent between objects;
3. Application of the cluster analysis method to create groups of similar objects (clusters);
4. Presentation of analysis results.

We presented conclusions and recommendations to determine the directions of regional development based on using the concept of "smart" benchmarking, which we described in detail earlier (Dubrovskaya et al., 2018). A feature of "smart" benchmarking is the preliminary identification of structurally similar territories, based on which the development priorities of the object under study are determined by introducing the successful experience of regions that are identical for it. From the substantive point of view, this means that for objective reasons, in the national context, not all indicators of the development of such leading regions as, for example, Moscow or St. Petersburg, can be achieved in practice by outsider regions in the foreseeable future. For this study, identical regions are considered as territories from the same cluster group. Accordingly, recommendations for improving development indicators are formed based on taking into account the positive experience and achievements of the leading regions of a particular group.

5.2. Data

This study is based on statistical data from the Federal State Statistics Service for 85 constituent entities of the Russian Federation for 2017.

The authors have developed a system of indicators that correspond to the methodology for calculating the I-DESI index to assess the development level of the region's digital environment (Table 1).

Table 1. System of criteria for calculating the regional index I-DESI

Criterion	Factor	Statistical indicator, unit of measurement	Designation
Communication	Deployment of broadband infrastructure of networks and its quality	The number of fixed broadband Internet subscribers per 100 people, units	com
Digital skills	Skills required to take advantage of the opportunities offered by the digital society	Share of people employed in the ICT sector in the total employed population,%	ICT
Use of the Internet by citizens	Variety of activities carried out by citizens on the Internet	Share of Internet users in the total population,%	usICT
Integration of business technologies	Digitization of business and development of an online sales channel	Share of organizations using ERP systems in the total number of surveyed organizations,%	ERP
Digital public services	Digitization of public services with the direction of the vector to the government	Share of state government (SG) and local self-government (LSG) bodies that had a data transfer rate of at	state

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

		least 2 Mbit / sec, in the total number of surveyed organizations of the SG and LSG bodies,%

The system of indicators described above is served as conducting a cluster analysis basis to typologise the Russian Federation regions according to the level of their digital development. The grouping results served as the basis for introducing an ordered logistic regression explainable variable. Statistical data used as regressors to assess the impact of technological modernization of the industrial sector on the level of regional digital development are shown in Table 2.

Table 2. A system of indicators for assessing the technological modernization impact in the industrial sector on the level of digital development in regions

Designation	Variable	Units of measurement
	Endogenous variable	
y	Digital development level of the region	-
	Exogenous variables	
inn	Costs for technological innovation	mln. rub.
org	Organizations that carried out scientific research, per 100,000 population	units / number of people
inc	Average per capita income, adjusted for the value of the consumer basket	Rub. / Rub.
high	Share of people employed in high-tech economic activities	%
middle high	Share of employed in medium-tech high-level economic activities	%
middle low	Share of employed in medium-tech low-level types of economic activity	%
low	Share of people employed in low-tech economic activities	%

Indicators high, middlehigh, middlelow, and low were calculated as the ratio of the average number of employees engaged in economic activities of different technological levels to the average number of employees in the full range of organizations. According to the level of technological

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

development, the division of activities is carried out in accordance with the list of high-, medium- and low-tech economic activities[2] developed by Eurostat based on Rosstat data.

At the same time, high-tech types of economic activity include: production of medicines; manufacture of computers, electronic and optical products; production of aircraft. Medium-tech high-level types of economic activities include: production of chemicals; manufacture of electrical equipment; repair and installation of machinery and equipment. Medium-tech low-level types of economic activities include: copying of recorded media; production of coke and petroleum products; manufacture of rubber and plastic products. Low-tech economic activities include: food production; beverage production; production of tobacco products; manufacture of textiles; production of leather and leather products; wood processing.

6. Findings

The authors carried out a cluster analysis using the Ward's method, five compact and well-separated clusters were obtained, which are quite amenable to economic interpretation. The quantitative characteristics of the obtained groups of regions are presented in Table 3.

Table 3. Quantitative characteristics of clusters

Group number, name and number of regions	Index	Average value	Minimum value	Maximum value	Standard deviation
1. Lagging type (15)	com	0.212	0	0.445	0.134
	ICT	0.246	0	0.545	0.145
	usICT	0.534	0	0.743	0.194
	ERP	0.187	0	0.316	0.102
	state	0.446	0	0.846	0.223
2. Catching-up type (39)	com	0.502	0.258	0.715	0.1
	ICT	0.264	0.061	0.494	0.112

[2] Eurostat. Statistics Explained. (2018, July 8). https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries

	usICT	0.526	0.355	0.701	0.079
	ERP	0.381	0.233	0.598	0.092
3. Middle link (7)	state	0.506	0.276	0.705	0.094
	com	0.617	0.519	1	0.171
	ICT	0.75	0.64	0.863	0.084
	usICT	0.472	0.287	0.64	0.135
	ERP	0.383	0.284	0.57	0.094
4. Progressive (21)	state	0.581	0.342	0.717	0.136
	com	0.691	0.504	0.887	0.081
	ICT	0.404	0.189	0.665	0.134
	usICT	0.579	0.314	1	0.167
	ERP	0.591	0.373	0.861	0.111
5. Leaders (3)	state	0.583	0.421	1	0.122
	com	0.807	0.552	0.953	0.222
	ICT	0.835	0.679	1	0.161
	usICT	0.728	0.691	0.748	0.032
	ERP	0.932	0.838	1	0.084
	state	0.835	0.787	0.908	0.064

According to the results obtained, the regions of the "Leaders" group (Moscow, Moscow Region, St. Petersburg) have the highest values for all five indicators. The largest number of regions (39 regions)

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

were included in the “catching-up type” group. In general, the level of digital development for the regions of this group is below average. However, in comparison with the regions of the “middle link”, the territories of the “catching-up” group are characterized by a high share of the population using the Internet. In the group of regions with an average level of digital development called "Middle link" (including such regions as the Udmurt Republic, Oryol region, the Republic of Mordovia and others), the average value of the share of people employed in the ICT sector is second only to the group "Leaders". The fifth group includes 15 regions lagging behind in all parameters of the digital environment development. The average values of digitalization indicators in the structure of the I-DESI index for five groups of regions are shown in Figure 1.

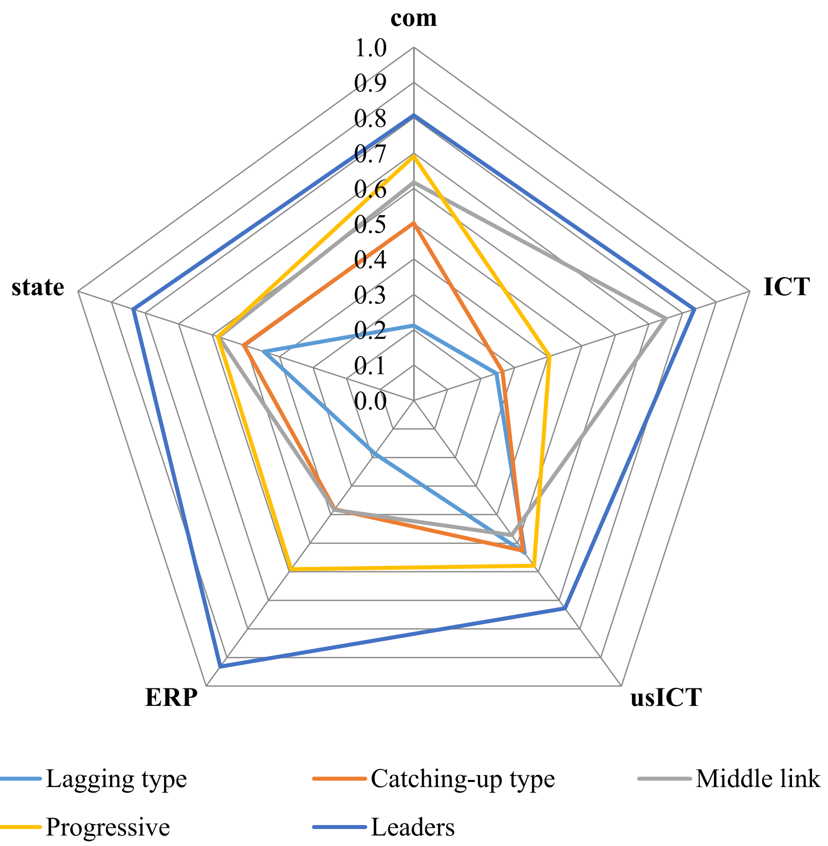

Figure 1. Average values of digitalization indicators in the structure of the I-DESI index in the groups formed

Further, based on the clustering results, an endogenous variable was determined, which takes the value 1 if the region belongs to the group of regions "Lagging type", 2 - "Catching type", 3 - "Middle link", 4 - "Progressive", 5 - "Leaders ".

The ordered logit model coefficients were estimated using the Stata 13 program and the maximum likelihood method. The obtained simulation results are shown in Table 4.

According to the simulation results, the level of digital development in regions, which determines the prospects and opportunities for the transition of the national economy to Industry 4.0, is more

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

influenced by the state of the high-tech economic activity types. The higher the share of people employed in high-tech activities, the higher the likelihood of the region's transition to a higher digital development level.

In addition, the transition of regions to a higher level of digital development at the 5% level of significance is influenced by such indicators as the share of those employed in medium-tech low-level types of economic activities and the level of costs for technological developments, and at the 10% level of significance we can observe the share of those employed in medium-tech high level of types of economic activities.

Table 4. Estimation results of ordered logit model coefficients (dependent variable - digital development level)

Variable		Coef.	Std. Err.	z	p-value
Costs for technological innovation	inn	0.00004	0.00001	3.48	0.001
Organizations that carried out scientific research, per 100,000 population	org	0.11829	0.20124	0.59	0.557
Average per capita income, adjusted for the value of the consumer basket	inc	1.03373	0.68338	1.51	0.130
Share of people employed in high-tech economic activities	high	0.20690	0.10107	2.05	0.041
Share of employed in medium-tech high-level economic activities	middle high	0.09786	0.05140	1.90	0.057
Share of employed in medium-tech low-level types of economic activity	middle low	0.12000	0.05071	2.37	0.018
Share of people employed in low-tech economic activities	low	0.04088	0.04734	0.86	0.388

Number of obs	85
Log likelihood	-85.58906
Pseudo R2	0.2444
LR chi2(7)	55.37
Prob > chi2	0.0000

Next, we analyzed the marginal effects of exogenous variables to determine the likelihood of a territory transition to a higher level of digital development. In other words, we calculated the percentage increase in the likelihood of moving to the next level of digital development if one of the independent variables changes, and the rest remain constant. The results of evaluating marginal effects are shown in Table 5.

The obtained results indicate that the regions of group 2 (catch-up type) have the highest probability of transition to the next level of digital development: an increase in any of the factors increases the probability of transition to group 3 (middle link) by more than 60%. For regions from the 1st group (lagging type), the greatest effect (18.5%) is generated by a change in the middlelow indicator (the share of employed in medium-tech low-level types of economic activity). This is quite consistent with the theoretical provisions that we disclosed earlier and indicating that outdated equipment and the lag in the development of basic sectors of the economy do not allow full-scale implementation of digital innovations.

In addition, the results obtained are in line with the main conclusion of the neoclassical economic growth model by Solow. According to his model, an increase in capital capacity (in this case, in the field of such low-tech economic activities as the production of food products, drinks, textiles, etc.) can provide high rates of economic growth until the territory reaches a balanced growth path.

Thus, as a result of convergence, regions of group 1 (lagging type) have a high chance of moving to group 2. It is rather difficult for the regions of group 3 (middle link) to move to a higher level of digital development (catching-up type): changing factors increases the probability of transition by an average of 8%.

This conclusion is consistent with the provisions of the path-dependence problem, according to which it is almost impossible for middle-class countries to make a breakthrough in economic development. And isolated cases of such breakthroughs (Japan, South Korea, etc.) are the exception rather than the rule.

https://doi.org/10.15405/epsbs.2021.04.55
Corresponding Author: Julia Dubrovskaya
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

Table 5. Estimation results for marginal effects

Marginal effects		**Variable**		
Variable	inn	high	middlehigh	middlelow
Dy/dx (1)	0.15860	0.14334	0.18169	0.18461
p-value (1)	0.002	0.005	0.020	0.010
Dy/dx (2)	0.63944	0.62064	0.64086	0.64082
p-value (2)	0.000	0.000	0.000	0.000
Dy/dx (3)	0.07725	0.09474	0.07892	0.08022
p-value (3)	0.011	0.009	0.023	0.017
dy/dx (4)	0.12276	0.22583	0.13735	0.14297
p-value (4)	0.001	0.000	0.009	0.004
dy/dx (5)	0.00194	0.005007	0.00244	0.00262
p-value (5)	0.393	0.342	0.369	0.358

Regions of the 4th group (catching-up type), for the transition to Leaders, need to increase the share of those employed in high-tech types of economic activity (the probability of transition is 22.6%), which is also consistent with the conclusions of the Solow's model with technical progress. So, according to the model, developed economies (in our case, regions of groups 4 and 5), which are on the balanced growth path, can increase the rate of economic growth only due to technological progress (in our model, this is the indicator "the share of people employed in high-tech economic activities").

7. Conclusion

The topic of digital modernization of the manufacturing industry is updated as a key factor in the transition of the economy to Industry 4.0 in the research. In the course of the study, using the example of Russian regions, it was proved that the likelihood and possibility of increasing the levels of digitalization in various territories depends on the current state of their economic and innovative development. At the same time, not all territories are ready for digital modernization. Thus, a number of regions must at least overcome the lag in the development of basic sectors of the economy; most regions need equipment modernization to start implementing digital innovations; and a full-scale digitalization in the leading sectors of the manufacturing industry takes place only in a few of the most developed regions. Thus, the findings are consistent with the provisions of the neoclassical growth theory that the growth trajectories of heterogeneous economies (which regional economies are) tend to their own balanced growth trajectories. And this is important to consider when developing regional digital development strategies.

We see the continuation of this research in detailing individual territories' data from the standpoint of "smart" benchmarking. So, at present we are developing a system of priorities for digital development for the Perm region based on comparing the indicators of its digital development with the parameters of identical regions of a single cluster group. These priorities can be the basis for the formation of strategic directions and programs for digitalization of the Perm region economy.

Acknowledgments

The reported study was funded by RFBR according to the research project № 19-010-00449

References

Abraham, T. W. (2018). Estimating the effects of financial access on poor farmers in rural northern Nigeria. *Financial Innovation, 4*(1), 1-20.

Akinwale, Y. O., Alaraifi, A. A., & Ababtain, A. K. (2019). Entrepreneurship, Innovation, and Economic Growth: Evidence from Saudi Arabia. *Eurasian Economic Perspectives, Eurasian Studies in Business and Economics, 15*(1). https://doi.org/10.1007/978-3-030-48531-3_3

Barinova, V. A., & Zemtsov, S. P. (2020). Inclusive growth and regional sustainability of Russia. *Regional Research of Russia*, *10*, 10–19. https://doi.org/10.1134/S2079970520010025

Dubrovskaya, Yu. V., Kudryavtseva, M. R., & Kozonogova, E. V. (2018). "Smart" benchmarking as a basis for strategic planning in regional development. *Economic and Social Changes: Facts, Trends, Forecast, 11*(3), 100–116. https://doi.org/10.15838/esc.2018.3.57.7

Inozemtsev, V. L. (2010). Modernization of Russia in context of globalization. *World economy and international relations, 2*, 90-103.

Kiyutsevskaya, A. M. (2019). Fintech: Current trends and challenges for monetary policy. *Voprosy Ekonomiki, 4*, 137-151. https://doi.org/10.32609/0042-8736-2019-4-137-151

Krugman, P. (1993). First Nature, Second Nature, and Metropolitan Location. *Journal of Regional Science, 33*(2), 129–144.

Kupriyanovsky, V. P., Sinyagov, S. A., Namiot, D. E., Utkin, N., & Dobrynin, A. P. (2016). On retail trade in the digital economy. *International journal of open information technologies, 4*(7), 1-10.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics, 107*, 407-437.

Meleddu, M., Pulina, M., & Scuderi, R. (2020). Public and private healthcare services: What drives the choice? *Socio-Economic Planning Sciences, 70*, 100739. https://doi.org/10.1016/j.seps.2019.100739

Shamin, A. E., Frolova, O. A., Shavandina, I. V., Kutaeva, T. N., Ganin, D. V., & Sysoeva, J. Y. (2020). Smart Village. Problems and Prospects in Russia. In T. Antipova, & Á. Rocha (Eds.), *Advances in Intelligent Systems and Computing* (pp. 480-486). Cham: Springer. https://doi.org/10.1007/978-3-030-37737-3_41

Sujarwoto, S., Tampubolon, G., & Pierewan, A. C. (2018). Individual and Contextual Factors of Happiness and Life Satisfaction in a Low Middle Income Country. *Applied Research in Quality of Life, 13*(4), 927-945.

Urasova, A. A. (2019). Regional industrial complex in the digital era: information and communication dimension. *Economy of the region, 15*(3), 684-694.

Zhou, G., & Luo, S. (2018). Higher education input, technological innovation, and economic growth in China. *Sustainability, 10*, 1-15.

Zhuk, A. A., & Fursa, E. V. (2019). Narrative analysis of institutional traps of education and science in Russia. *Journal of institutional studies, 11*(1), 176-193.