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A COMPARATIVE ANALYSIS OF INNOVATIVE PRODUCTION FACTORS IN THE RUSSIAN FEDERATION REGIONS

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Abstract

The hypothesis, according to which the direction of financial capital flows and the transfer of high technologies in developed national economies are mainly determined by the potential of human capital located in a specific territory, is tested in the article. In the era of the fourth industrial revolution, human capital becomes a strategic production factor for innovative economic growth. This study is aimed at analyzing the relevance of the current state of human capital of the Russian Federation regions to the level of innovative development of regional economies. To test the working hypothesis, an analytical algorithm was used to structure the data by factors of monitoring the development of the information society in the Russian Federation and the main indicators of science, innovations and advanced manufacturing technologies in the Russian Federation. The specifics of the development of this approach is the formation of a factor structure in the format of many clusters of the Russian Federation regions, differing in the level of development of human capital and the use of the advantages of disruptive technologies. A comparative analysis was carried out according to the following groups of factors for the Russian Federation regions: human capital, innovative capacity, science, innovations and advanced manufacturing technologies. The working hypothesis of the study, tested on the statistical data of the Russian Federation regions, is only partially confirmed.

Keywords: Human capital, innovative growth, digital economy, regional economy.

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1. Introduction

The sustainable production growth of new qualitative characteristics of human capital is an important component of the strategy of innovative development of the world economy in the era of Industry 4.0. The prevalent success factor of innovative ventures in the territories is the concentration of highly qualified human resources acting as generators of innovative activity of strategic importance for the development of regional high-tech production. A number of researchers argue that economies "compete through people", sustainable innovative development depends on human capital, as well as the ability to manage talent (Chiappori, Galichon, & Salanié, 2019). The practice of capitalizing the workers' research and productive capacity has a direct impact on the current state and development prospects of the high-tech sector of the economy in specific territories (Fletcher & Han, 2019).

2. Problem Statement

In developed countries, during the era of the fourth industrial revolution, individuals equipped with developed human capital, combining both cognitive and non-cognitive skills, become a strategic production factor in the competitiveness of the economy. The winner in the competition is the economy, where not only new business ideas are generated, but also permanent processes of commercialization of innovations and their implementation in economic activity are organized. Human capital becomes a trigger for economic growth in the context of the fourth industrial revolution (Bucci, 2015; Lucas, 2018).

World practice of implementing the Industry 4.0 concept in industrial production confirms the hypothesis that human capital is becoming one of the main factors affecting investment decisions to localize high-tech production activities in a specific territory. Today, inter-territorial flows of financial capital and transfer of disruptive technologies are oriented not so much to territories rich in natural resources as carriers of human capital. Until recently, one of the main motives for making investment decisions was the availability of cheap labour in the territory. Whereas at the present time, highly qualified human resources and the availability of a local research base are becoming a priority resource that shapes decisions to invest in innovative industries. The territorial concentration of skilled workers, their knowledge and skills determine the investment attractiveness of the territory (Acemoglu & Restrepo, 2018).

The growth of global mobility of production and the short life cycle of innovative products leads to the fact that new industries are located where the concentration of human capital is high (Cauchie & Vaillant, 2016). The most important role of human capital is due to the fact that the most advanced industries and technologies are knowledge-consumptive, and they determine the dynamics of innovative growth (Ehrlich, Li, & Liu, 2017). Undoubtedly, factors such as the sales market, operating costs, national tax laws, and logistics are important when deciding on the location of a business. However, even the most favourable conditions do not facilitate the inflow of investments without the presence of human capital equipped with high-tech professional competencies.

The objectivity of the research of disruptive technologies in Industry 4.0, together with the economic analysis of human capital, is reflected in the International Digital Economy and Society Index (I-DESI), which is used in world practice to measure the progress of countries in the development of the digital economy and society. The index values for countries in 2016 are presented in Table 01.

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Table 01. Countrywise International Digital Economy and Society Index: 2016

Country	Digital Economy and Society Index (I-DESI)	Including subindices				
		Connectivity	Human Capital	Use of Internet	Integration of Digital Technology	Digital Public Services
Iceland	0.66	0.69	0.66	0.61	0.73	0.58
Republic of Korea	0.64	0.81	0.75	0.29	0.47	0.73
Norway	0.63	0.70	0.65	0.45	0.66	0.63
New Zealand	0.63	0.62	0.59	0.44	0.79	0.65
Japan	0.62	0.71	0.66	0.22	0.67	0.71
USA	0.62	0.66	0.56	0.37	0.68	0.79
China	0.61	0.75	0.61	0.30	0.78	0.49
Australia	0,6	0.59	0.56	0.42	0.75	0.69
Canada	0.59	0.63	0.62	0.42	0.58	0.67
EU-28 countries	0.54	0.61	0.59	0.38	0.55	0.47
Ireland	0.52	0.53	0.61	0.37	0.50	0.55
Russia	0.47	0.50	0.63	0.32	0.43	0.36
Turkey	0.31	0.39	0.49	0.35	0.39	0.38
Brazil	0,38	0.41	0.40	0.27	0.46	0.34
Mexico	0.34	0.33	0.46	0.20	0.30	0.35

Source: authors base on (Abdrakhmanova et al., 2018).

In Russia, there is a gap in the values of the I-DESI index (0.47) and the Human Capital subindex (0.63) of this index. Cross-country analysis of the ratio of these values has shown that Russia is superior to many economies developed in the field of high-tech in terms of the Human Capital subindex, in particular, the USA, EU-28 countries, Canada, China, Australia, New Zealand and is inferior to these countries in terms of development digital economy and society. The proportion of people employed in the information and communication technology sector in the total number of employed people in Russia during the period from 2010 to 2018 remains as low as at 1.6% (Federal State Statistic Service of Russian Federation, 2018a).

3. Research Questions

Human capital is primarily a carrier of skilled labour and technological knowledge, which form the basis of scientific and technological progress (Angelopoulos, Malley, & Philippopoulos, 2017). It plays a decisive role in the development of modern disruptive technologies and is an important factor in their effective use. "This means that the more important are no longer the technologies, but the people who develop them" (Zhudro & Zhudro, 2017, p.84). The development of telecommunication and information technologies requires that their creators and users have a high technological IQ and an appropriate level of interdisciplinary competencies, creating a qualification profile of the territorial "attraction" of investments. Today, such a qualification profile of the territory is crucial for the location of high-tech activities.

The current state of the constituent entities of the Russian Federation (RF) in terms of human capital development and digitalization of the economy is heterogeneous. Changes in the method and structure of production and employment in the constituent entities of the Russian Federation, as well as the widespread

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penetration of digital technologies and skills in all spheres of life are strategic challenges that regional authorities must meet in the era of digital globalization, which intensifies competition at the mesoscale.

4. Purpose of the Study

The purpose of this study is to test the relevance of the global trend of dependence of inter-territorial flows of financial capital and the transfer of high technologies largely on the potential of human capital located in a specific territory. This study is aimed at analysing the relevance of the current state of human capital of constituent entities of the Russian Federation to the level of innovative development of regional economies.

5. Research Methods

To achieve this goal, an analytical algorithm was used for structuring data by factors of monitoring the development of the information society in the Russian Federation (Federal State Statistic Service of Russian Federation, 2018a) and the main indicators of science, innovations and advanced production technologies in constituent entities of the Russian Federation for the period of 2010 – 2018 (Federal State Statistic Service of Russian Federation, 2018b). The specifics of the development of this approach consists in the shaping of a factor structure in the format of many clusters of the constituent entities of the Russian Federation, differing in the level of development of human capital and the use of the advantages of disruptive technologies.

Cluster formation is based on the analysis of statistical data by factors of human capital development and digitalization in the constituent entities of the Russian Federation through the method of cluster analysis, which allows identifying internal, directly immeasurable relationships between correlating factors. The procedure for cluster analysis of multidimensional data was carried out by the method of EM (Expectation Maximization). The method was implemented in the integrated development environment Rstudio using the mclust library, designed for statistical data processing and graphics.

6. Findings

A comparative analysis was carried out according to the following groups of factors for all constituent entities of the Russian Federation:

- Human capital;
- Innovative capacity;
- Science, innovation and advanced manufacturing technologies.

According to the factors of the groups “Innovative Capacity” and “Human Capital”, there is mainly a mismatch in the composition of entities that form clusters of the same rating. The number of matches in cluster composition is only 19 (22.6% of the total number of constituent entities of the Russian Federation, Table 02).

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Table 02. Cluster rating of constituent entities of the Russian Federation

The composition of clusters formed from constituent entities of the Russian Federation (serial numbers)																	
Ranking	**Human Capital**					**Ranking**	**Innovative Capacity**					**Ranking**	**Science, Innovation and Advanced Manufacturing Technologies**				
1	18	28				1	10	18	28	52		1	18				
												2	10	28	52	55	59
													63				
2	1	4	8	11	12	2	3	4	6	15	24	3	1	9	16	26	30
	13	23	30	33	35		35	59	63	70	73		47	70	75		
	43	46	47	49	52		74	75									
	55	56	57	62	63												
	73	74	75	78	79												
3	2	3	5	6	7	3	9	16	17	46	47	4	4	5	6	7	8
	9	14	15	16	17		49	50	54	55	79		14	17	25	35	46
	19	21	22	25	26		82						50	57	62	73	79
	27	32	45	51	54							5	15	24	61	71	72
	68	72	82	83									74	78			
4	20	44	48	50	53	4	29	43	57	69	80	6	3	32	44	48	56
	58	64	65	67	69												
	70	71	76	80	81												
5	66	77	84			5	8	13	21	25	32	7	2	11	12	13	19
							34	39	56	62	64		20	21	22	23	27
							65	68	71	77	78		29	31	33	34	36
							81	83					37	38	39	40	41
6	10	24	29	31	36	6	1	2	7	11	12		42	43	45	49	51
	37	39	40	41	60		14	20	22	26	27		53	54	58	60	64
	61						33	44	45	48	51		65	66	67	68	69
							53	58	60	84			76	77	80	81	82
7	38	42				7	5	19	23	30	31		83	84			
							36	37	38	40	41						
							42	61	66	67	72						
							76										

Source: authors.

A relatively full compliance in the cluster ratings was established for the following constituent entities of the Russian Federation: Moscow and St. Petersburg, Voronezh Region, Rostov Region, Chelyabinsk Region, Novosibirsk Region, Omsk Region, Tomsk Region, Lipetsk Region, Tula Region, Yaroslavl Region, Penza Region, Sakhalin Region, Trans-Baikal Territory, Amur Region, Kamchatka Territory, Khanty-Mansiysk Autonomous Region, Republic of Ingushetia, Chechen Republic. In the Kaliningrad Region and the Republic of Kalmykia, on the contrary, asymmetries were revealed in terms of the rating of human capital development (ranking No. 2) and innovative capacity (ranking No. 7). The serial numbers of the constituent entities of the Russian Federation are presented in Table 03.

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According to the factors of the groups "Science, Innovations and Advanced Manufacturing Technologies" and "Human Capital", there is also a low degree of compliance in the composition of entities that form clusters of the same rating. The number of matches in the constituent entities of the Russian Federation that form clusters makes less than one third of the total number of constituent entities of the Russian Federation.

7. Conclusion

The results of the comparative analysis demonstrate a low degree of matching between the levels of accumulation and effective use of human capital and the levels of innovative capacity and the development of science, innovations and the use of advanced manufacturing technologies of the constituent entities of the Russian Federation. The working hypothesis of the study, according to which the direction of financial capital flows and the transfer of advanced technologies are mainly determined by the available potential of human capital localized in a specific territory, tested on the statistics of the constituent entities of the Russian Federation, is only partially confirmed. Therefore, when making a managerial decision on the creation and development of high-tech innovative industries in the constituent entities of the Russian Federation, the significance of the presence of developed human capital in the territory currently makes up from 20 to 30% of the total number of administrative, financial, natural, social and other factors affecting the investment attractiveness of the region.

Table 03. The serial numbers of the constituent entities of the Russian Federation

No	Constituent entities of the Russian Federation	№	Constituent entities of the Russian Federation
1	the Belgorod Region	43	the Stavropol Region
2	the Bryansk Region	44	the Republic of Bashkortostan
3	the Vladimir Region	45	the Republic of Mari El
4	the Voronezh Region	46	the Republic of Mordovia
5	the Ivanovo Region	47	the Republic of Tatarstan
6	the Kaluga Region	48	the Udmurt Republic
7	the Kostroma Region	49	the Chuvash Republic
8	the Kursk Region	50	the Perm Territory
9	the Lipetsk region	51	the Kirov Region
10	the Moscow region	52	The Nizhny Novgorod region
11	the Oryol Region	53	the Orenburg Region
12	the Ryazan region	54	the Penza Region
13	the Smolensk region	55	the Samara Region
14	the Tambov region	56	the Saratov Region
15	the Tver region	57	the Ulyanovsk Region
16	the Tula region	58	the Kurgan Region
17	the Yaroslavl region	59	the Sverdlovsk Region
18	the city of Moscow	60	the Khanty-Mansijsk Autonomous District
19	the Republic of Karelia	61	the Yamalo-Nenets Autonomous District
20	the Republic of Komi	62	the Tyumen Region (not Autonomous District)
21	the Arkhangelsk region	63	the Chelyabinsk Region
22	the Vologda region	64	the Republic of Altai
23	the Kaliningrad region	65	the Republic of Buryatia

24	the Leningrad region	66	the Republic of Tuva
25	the Murmansk region	67	the Republic of Khakassia
26	the Novgorod region	68	the Altai Territory
27	the Pskov region	69	the Zabaikalye Territory
28	the city of St. Petersburg	70	the Krasnoyarsk Region
29	the Adygeya republic	71	the Irkutsk Region
30	the Republic of Kalmykia	72	the Kemerovo Region
31	the Republic Of Crimea	73	the Novosibirsk Region
32	the Krasnodar region	74	the Omsk Region
33	the Astrakhan region	75	the Tomsk Region
34	the Volgograd region	76	the Republic of Sakha (Yakutia)
35	the Rostov region	77	the Kamchatka Region
36	the city of Sevastopol	78	the Primorye Territory
37	the Republic of Dagestan	79	the Khabarovsk Territory
38	the Ingush Republic	80	the Amur Region
39	the Kabardino-Balkar Republic	81	the Magadan Region
40	the Karachay-Cherkess Republic	82	the Sakhalin Region
41	the Republic Of North Ossetia-Alania	83	the Jewish Autonomous Region
42	the Republic Of Chechnya	84	the Chukotka Autonomous District

Source: authors.

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