

THE IMPACT OF THE QUALITY OF HUMAN CAPITAL AND STATE EDUCATIONAL POLICY ON THE DEVELOPMENT OF HIGH-TECH COMPANIES IN RUSSIAN REGIONS

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Abstract

This article explores the role of human capital for innovative activity of Russian high-tech companies. Taking into account the weaknesses in educational system and the last reforms, we hypothesize that high-qualified human capital have a positive impact on labor productivity of high-tech firms. At the same time we hypothesize that the last reforms of the Ministry of science and higher education have a positive impact on firms' innovation activity in Russia. We test our ideas using "TechUspech" rating data for 2017. Our findings indicate a positive significant association between the highly qualified human capital and labour productivity of Russian innovative firms. The empirical analysis also revealed the positive impact of recent reforms of the Ministry of Education and Science on the innovation climate in the regions of the country.

Keywords: Human Capital, State Educational Policy, Russian Regions

1. Introduction

Russia faced a rapid growth in the early 2000s, the crisis of 2008, the subsequent slow growth and the current recovery after the 2014–2015 crisis. At the moment, world GDP is significantly ahead of the growth of the Russian economy (McKinsey, 2017). Today, the country is in search of new sources of economic growth. Despite all the efforts of the government, innovative activity of Russia is extremely low, in comparison with other countries. In this respect Russia is 9 times behind the world leader of Switzerland (Dvoreckaya, 2018). The rate of innovative firms remains 2-3 times lower than that of developed countries. Thus, in 2011 the rate of innovative companies was 10.4%. In 2016 this index decreased to 9.2%. (Dvoreckaya, 2018).

As for the innovative products output, its constant prices doubled from 59.7 billion rubles to 123.9 billion in 2006–2016. On average, the level of innovative products to the total output is 8.4%, varying by industry: it is slightly higher in the manufacturing industry (10.9%) and explicable below in agriculture, in construction. However the scientists notes the poor-quality structure of innovative output. Thus, the national production of medical and computing equipment is clearly inadequate (it does not even reach 10% of consumption). There is almost no production of domestic consumer electronics in the country (Dvoreckaya, 2018). In Russia, the government traditionally plays a huge role in the economy. Therefore, the innovative activity of the public sector is higher than the national average.

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Thus, state corporations (among them Rosnano, Rostech), has the share of innovative products at about 34% with the national average of 8.4%.

However, this does not guarantee a higher quality level of innovation in state-owned companies. As a rule, medium-sized fast-growing tech companies (gazelles) represent the main source of innovations in countries (Gorodnikova et al., 2016; Barinova et al., 2015).

Many authors see growth potential for the Russian economy in the development of human capital (Butenko et al., 2017). The training system is a central function in innovative systems. People capable to solve creative tasks are needed for the development of national and regional innovation systems. It means that Russia needs a significant transformation of the traditional system of education. Therefore, the purpose of this study is to determine the impact of highly qualified human capital on the innovative development of high-tech enterprises, as well as to identify the effectiveness of state educational policy on the development of high-tech companies in Russian regions.

2. Literary review: the impact of human capital on the innovative potential of the company

Firms are the main source of innovation (Boyer et al. (1998). Knowledge is a very important resource for business development, therefore the attraction and retention of scientists and engineers is of paramount importance for innovative firms (Marcum et al. 2014). Despite the fact that universities and government institutions play an important role in creating new products, most of the applied research in the world is carried out by the private sector (Marcum et al. 2014). Many empirical studies show a positive relationship between the costs of R & D and the innovative activity of the company. The rapid spread of new technologies is forcing managers hire a highly qualified staff. The abilities of the employees of the company influence not only the type, range and quality of products, but also the flexibility and the speed of the production process. The effectiveness of company's R&D depends largely on the ability of its scientists to adapt and create new knowledge. Without the required number of scientists, a firm cannot use new available technologies (Leiponen, 2005). Innovation analysis is impossible without analyzing the market for scientists in enterprises. In addition, a more educated and qualified workforce can not only successfully introduce new technologies, but also be a source of innovation, since education or previous training significantly increases the employee's ability to create innovations in the company.

According to Nelson and Phelps (Nelson & Rosenberg, 1993), education enhances people's ability to receive, interpret and understand information. The level of education is especially important for industries that require strong adaptation to technological change. According to the study of Bartel and Lichtenberg (Bartel & Lichtenberg, 1987), the higher the uncertainty of the working environment, the higher the productivity of highly educated employees compared to those of the least educated. The most highly educated people have a comparative advantage in the implementation of innovations compared to other graduates. Wozniak (Wozniak, 1987) also associates the level of human capital with the diffusion of technology within firms. Given the complexity of R & D, firms need a significant share of high-level graduates (Corvers, 1997). Lee, Wong, Chong (Lee et al., 2005) found that graduate firms with a PhD degree

are more effective in research and development in firms, which manifests itself in more patents and publications than other employees.

On the other hand, the R & D department in companies can also facilitate the rapid adaptation of knowledge. According to Cohen and Levinthal (Cohen & Levinthal, 1989), R & D activities develop the ability of companies to identify, absorb and use the knowledge of other companies, research institutes or even universities. The firm's capacity to absorb knowledge will depend on the level of education and training of employees in R & D (Vinding, 2006). Rothwell and Dodgson (Rothwell & Dodgson, 1991) show the importance for small firms to have highly qualified scientists and engineers in their staff to gain access to external knowledge. Scientists contribute to assimilation of external knowledge, and their distribution among other departments of the company. Therefore, within the framework of research activities, human capital is characterized by a very high level of initial training, which makes it possible to use both innovative and absorption capabilities.

In view of these arguments we hypothesize that human capital and the last reforms aimed its development have a positive effect on innovation activity of Russian firms.

In order to study the effect of the quality of human capital on Russian high-tech companies, we divide our empirical analysis into 2 parts. In the first part, we identify the factors that affect the labor productivity of Russian high-tech enterprises, and in the second part, we consider the impact of educational policy reforms on the development of regional high-tech companies.

Part 1. Identifying the factors that have an influence on the labor productivity of high-tech firms in the Russian Federation

Sample

The study used a sample of 243 Russian high-tech companies that took part in the survey of the TechUspech rating for 2017. TechUspech rating is aimed at identifying fast developing Russian companies operating in the field of high technologies. Companies that meet the following qualification requirements were invited to participate in the Rating (Table 1).

The selection of companies for the rating takes place by questioning the participants: the companies independently fill out a questionnaire. TechUspech checks then if the company meets the requirements. On request, TechUspech representatives provide access to the microdata of company surveys.

A sample of TechUspech represents particularly high-tech companies in Russia. On its basis, it is possible to carry out modeling of labor productivity per employee of enterprises participating in the rating. The microdata base presents the number of employees with academic degrees employed in the enterprise, in addition to other factors of innovation activity of enterprises,. This indicator will help us identify the impact of higher-level scientific personnel on the labor productivity of Russian high-tech firms.

The sample description is presented in table 2 and the figures in the Annex

Table 1 - Requirements for companies participating in TechUspech rating

№	Requirement
1	The company's revenue for 2017 is from 100 million rubles up to 30 billion rubles; Based on the indicator, the company's revenues are divided into 3 subcategories: - Small (from 100 million rubles to 800 million rubles); - Medium (from 800 million rubles to 2 billion rubles); - Large (from 2 billion rubles to 30 billion rubles).
2	The average annual growth rate revenue for the last 5 years (2013, 2014, 2015, 2016 and 2017): - For small companies - at least 20%; - For medium-sized companies - at least 15%; - For large companies up to 10 billion rubles. - not less than 12%; - For large companies more than 10 billion rubles. - not less than 10%.
3	during the last 5 years (2013, 2014, 2015, 2016, 2017), the company has no more than two periods of revenue decline of more than 10% were observed;
4	over the past 5 years (2013, 2014, 2015, 2016, 2017), the company introduced to the Russian market at least one new or substantially improved product / service, developed on the basis of its own or acquired R & D results;
5	the share of revenue from sales of such new products / services has averaged over the past 3 years (2015, 2016, 2017): - For small and medium-sized companies - at least 30%; - For large companies up to 10 billion rubles. - not less than 25%; - For large companies more than 10 billion rubles. - not less than 20%.
6	average R & D expenditures are not less than 5% of the revenue for the last 3 years (2015, 2016, 2017);
7	average expenditures on technological innovation are not less than 10% of revenue over the past 3 years (2015, 2016, 2017);
8	The minimum age of the company is 4 years.

Source: The official website of TechUspech rating. Methodology rating TechUp, URL: <http://www.ratingtechup.ru/about/methodology/>

Table 2. Shares of Regions

% of Region	Regions
29	Moscow
17	Moscow Region
10	St. Petersburg
5	
4	
2	

Table 3. Shares of Sectors

% of Sector	Sectors
20	Information technology
19	Electronics & Instrumentation
13	Materials and Chemistry
9	
8	
6	
2 or 3	

As the table shows, most companies in the rating are located in Moscow (29%) and St. Petersburg. This specific must be considered when modeling the productivity of employees of innovative firms.

TechUspeh sample includes mainly companies of the following industries: information technology, electronics and instrumentation, materials and chemistry, mechanical engineering.

Measures

Dependent variable

Labor productivity (or revenue per employee, as in our case) is one of the key indicators of a firm's competitiveness. High labor productivity indicates the high quality of the company's labor resources. Revenue per employee of a company may reflect demand and competitiveness of the company's products.

As a basis for the analysis, we used the model from the article by S. Black and L. Lynch "What drives the new economy?: benefits from innovation in the workplace". This methodology has already been used in the work of V. A. Barinova, S. P. Zemtsova, A. V. Sorokina. "An Empirical Analysis of the Factors of the Competitiveness of Domestic High-Tech Companies" [4]. In our study, we modified based on work objectives and available data.

$$\ln(Sales_{p_{empl}}) = \beta_0 + \beta_1 \times \ln(New_{prod_{p_{empl}}}) + \beta_2 \times \ln(Rnd_{p_{empl}}) + \beta_3 \times \ln(PhD_{p_{empl}}) + \beta_4 \times \ln(Age) + \beta_5 \times \ln(Patents_{p_{empl}}) + Regional\ factors + \varepsilon, \quad (1)$$

Where $Sales_{p_{empl}}$ - revenue per employee, thousand rubles / person; $New_{prod}_{p_{empl}}$ - The volume of new products per employee; $Rnd_{p_{empl}}$ - research and development costs per employee, $PhD_{p_{empl}}$ - number of employees with academic degrees per employee, $Patents_{p_{empl}}$ - patents per employee, Age - company age, $Regional\ factors$ - regional features that may affect the productivity of one company (in this case, we introduce a binary variable that takes the value 1 if the company is located in Moscow or St. Petersburg, and 0 if it is in other regions), ε is a random model error.

Table 4 - Correlation Matrix of Independent Variables

	Age of the company	The volume of new products per employee	R & D costs per employee	Share of scientists	Patents per employee
Age of the company	1				
The volume of new products per employee	0.00957	1			
R & D costs per employee	0.07209	0.638854	1		
Share of scientists	0.017187	0.349986	0.428712	1	
Patents per employee	-0.01371	0.181052	0.101856	0.412953	1

Since the production function model uses logarithms, and the distribution of the dependent variable is far from normal, it was decided to log all indicators. At the same time, after this transformation, the distributions of most of the variables (dependent and independent) became close to the normal one.

Since the correlation matrix (table 4) showed the absence of strong connection between our indicators (above 0.7), we assume the absence of multicollinearity.

Results

The results of the regression model are presented in table 3.

Table 3 - The main results of model 1

<i>Sales p empl</i>		
	1.1	1.2
<i>New prod p empl</i>	0,023** (0,012)	0,025*** (0,011)
<i>RnD p empl</i>	0,038*** (0,011)	0,029** (0,011)
<i>Phd p empl</i>	0,004 (0,008)	0,002 (0,007)
<i>Patents p empl</i>	-0,017 (0,010)	-0,014 (0,010)
<i>Age</i>	0,087 (0,055)	0,109** (0,055)
<i>Regional factors</i>		0,361*** (0,120)
Const	7,766*** (0,179)	7,575*** (1,187)
F-statistics	5,971***	6,651***
R ²	0,334	0,380
Number of observations	243	243

Regression analysis showed a significant positive impact of production of new products, as well as R&D expenditures on the productivity of employees of the company. In the first specification of the model, there is no significant effects of the share of workers with academic degrees, the share of patents per employee and the age of the company. However, with the addition of a variable characterizing the companies situated in Moscow or St. Petersburg, the age variable has a significant positive effect on the productivity of employees. Thus, the positive influence of the age of the firm on the productivity of employees takes place mainly in Moscow and St. Petersburg.

Model 1 showed the relationship between dependent and independent variables of a logarithmic nature. However, we assume that the relationship can be not only the log-log form, but also the log-lin form. To test this hypothesis, we take the natural value of one of the insignificant variables in model 1, namely, the variable “Number of employees with academic degrees per employee” and build a regression model. The regression results are presented in table 5.

The transformation of a variable share of employees with academic degrees into a linear form showed its significance. Thus, the regression analysis shows the positive impact of highly skilled human capital on the labor productivity of highly innovative firms in Russia. At the same time, the number of patents registered with the company has a significant negative impact. Thus, at the individual level of Russian firms, scientific human capital increases the innovative activity of firms.

Table 5 - The main results of model 2

<i>Sales p empl</i>		
	2.1	2.2
<i>New prod p empl</i>	0,022* (0,012)	0,024** (0,012)
<i>RnD p empl</i>	0,039*** (0,011)	0,029*** (0,011)
<i>Phd p empl</i>	0,751** (0,008)	0,681* (0,363)
<i>Patents p empl</i>	-0,020** (0,009)	-0,018* (0,009)
<i>Age</i>	0,100* (0,055)	0,121** (0,055)
<i>Regional factors</i>		0,349*** (0,120)
Const	7,630*** (0,177)	7,466*** (1,183)
F-statistics	6,852***	7,321***
R ²	0,355	0,396
Number of observations	243	243

Part 2. The impact of state educational initiatives on the innovation activity of firms in Russian regions

Program	Description
Dual vocational training system ¹	At the moment, the system of vocational education in Russia cannot form a sufficient amount of applied competencies. In this regard, one of the most promising measures is the reform of the system of vocational education is “dual education system”. In order to introduce dual education in Russia, in 2013 the Agency for Strategic Initiatives launched a pilot project that formed training and production clusters of the German model in 13 Russian regions. The project participants included subjects of the Russian Federation with successful investment experience, including the Moscow, Nizhny Novgorod, Sverdlovsk, Kaluga and Perm regions, as well as the Republic of Tatarstan and the Krasnoyarsk Territory. 2016 These regions had necessary conditions for the implementation of a dual vocational education, close to the original German prototype. The educational and methodological elements of this model (updated curricula and plans, mentoring, etc.) were organically included in the relevant economic and business context and focused on the training of personnel for the high-tech sectors of the Russian economy. According to the Agency for Strategic Initiatives, over 16,000 students were trained at enterprises. It can be said that today educational practices within the framework of the dual model of education are fully formed. The regions have developed managerial, organizational and financial mechanisms that support this model, and dozens of major companies have joined the of programs.
5 top 100 ²	The goal of the 5/100 project is to include at least five Russian universities in the first hundred of the world's leading universities by 2020 according to the world university ranking. The Russian League of University Excellence has been defined - 21 universities (including 5 federal universities and 12 NRUs) that participate in the project to increase international competitiveness. The program is valid until 2020. Since 2013, the state has provided a solid support to these universities. In 2016 government invested

¹ Source: http://asi.ru/staffing/dualeducation/docs/Metod_Recommendation_2.0.pdf

² Source: <https://www.5top100.ru/>

	12.5 billion rubles in the project. Serious state financial support has made it possible to achieve significant results in promoting Russian universities in world rankings. In 2017, 11 Russian universities entered the TOP-100 and 17 Russian universities - in the TOP-200 of the world's institutional, subject and industry ratings. However, in order to fulfill the objectives of the "5 Top 100" project, leading universities of the country strive to meet the criteria for evaluating world ratings such as Quacquarelli Symonds, Times Higher Education and Academic Ranking of World Universities, which do not take into account the interaction of universities with employers.
Program "Opornij universitet"³ (Supporting university)	Today, 33 regional universities from 32 Russian regions have the status of "Opornij universitet" (regional universities that are located outside of Moscow and St. Petersburg may take part in the competition). Development programs of supporting universities envisage the implementation of the following areas: modernization of educational activities; modernization of research and innovation activities; human resource development; modernization of the university management system; modernization of material and technical base and socio-cultural infrastructure; development of local communities in urban and regional environments. In addition, supporting universities should become centers of competence in the field of technological and social entrepreneurship in the regions. The key guidelines for supporting universities are: attract talented young people to stay in the region; involve leading scientists and talented teachers of the country in the educational process, including virtual academic mobility; provide sustainability and effectiveness of network partnerships with business, government, public organizations; contribute to high rates of employment of graduates in the enterprises of the region; demand for additional professional programs being implemented by key employers in the region and by regional authorities
The program of development of export of Russian education	In 2017, a consortium of 22 leading universities in Russia drafted and adopted a priority project "Development of the export potential of the Russian education system"⁴, which aims at developing digital education and expanding tasks related to export of Russian educational programs on the international market. Within the framework of this project, the Ministry of Education and Science of the Russian Federation set a goal to assess the scope of university online education in Russia and determine the ways of its development. Within the project a database of universities in Russia implementing online education, as well as those who are going to implement such programs in the near future was created. Open education brings new opportunities for innovation in higher education that will allow institutions and academics to explore new online learning models and innovative practices in teaching and learning (Alrawi and Jaber, 2008). Therefore, the collected data can help in analyzing the effectiveness of Russian online education on the innovative activity of regions (Ponomarenko et al., 2018).

³ Source: <http://xn--b1agajcc1abgakngoqbh6l.xn--p1ai/>

⁴ <http://government.ru/projects/selection/653/28013/>

In this paper, using the "TechUspeh" rating database, we can also see the effectiveness of recent initiatives in terms of improving human capital and increasing the innovation activity of firms.

Measures

Dependent variable. From the database provided by "TechUspeh", we selected those firms that were included in the rating. Then we calculated the number of fast-growing technology companies that were included in the "TechUspeh" for each region. As a result, we obtained a dependent variable consisting of a number of companies corresponding to each region (table 6).

Table 6. Regional structure of TechSuccess rating winners: Number of companies included in TS Rating

Region	Number of companies	Region	Number of companies
Moscow	32	Yaroslavl region	2
St. Petersburg	18	Tyumen region	2
Nizhny Novgorod Region	6	Republic of Mordovia	2
Novosibirsk Region	6	Krasnodar Region	2
Moscow region	5	Saratov region	2
Chelyabinsk Region	5	Krasnoyarsk region	2
Udmurt Republic	5	Irkutsk region	1
Sverdlovsk region	4	Stavropol Territory	1
Republic of Tatarstan	4	Novgorod region	1
Samara region	4	Orel region	1
Tomsk region	4	Ryazan region	1
Kaluga region	4	Ulyanovsk region	1
Perm Region	3	Altai Territory	1
Republic of Bashkortostan	3	Republic of North Ossetia-Alania	1
Vladimir region	3		
Belgorod region	2	Vologda Oblast	1

Note: Number of Companies in TechSuccess Rating (TS rating).

Independent variables. To check the impact of the latest policies on the innovation activity of firms in the regions of the Russian Federation, we selected the following indicators - independent variables (Table 16).

Independent variables. To check the impact of the latest policies on the innovation activity of firms in the regions of the Russian Federation, we selected the following indicators - independent variables (Table 7).

The disadvantage of the last two variables is the fact that the statistics are presented only for courses developed in English. However, in our opinion, it can give an idea of the development of online education in the region, as more and more popular are the English-language programs, which are potentially aimed at exports and are of high quality. More and more Russian students are choosing English language programs to improve their professional skills and English for business communication. Thus, these

courses also train professionals who are able to work in international markets and export products abroad.

Table 7. Data source of independent variables for modeling

Indicator	Data source
Participation in the programme for the introduction of a dual system in secondary vocational education	Methodological recommendations on the implementation of the dual model of training highly qualified workers, ASI 2016.
Number of higher education institutions participating in the program 5 top 100 in the region	Ministry of Science and Higher Education of the Russian Federation, Project 5-100, official website https://www.5top100.ru/universities/
Presence of a supporting university in the region (1st part of the competition in 2016)	Federal portal "Russian Education" http://www.edu.ru/vuz/opornye-vuzy?page=2
Number of MOOCs provided by higher education institutions in the region in English, posted on the international platforms Coursera and edX	Quantitative research including online survey of 365 Russian higher education institutions in December 2017 within the framework of the project "Development of export potential of the Russian educational system"
Number of online courses in English on internal university platforms like Moodle and Sakai	Quantitative research, including online survey of 365 Russian higher education institutions in December 2017 as part of the project "Development of export potential of the Russian educational system"

Thus, the regression equation for our study looks as follows:

$$TehUspehnumber = \beta_0 + \beta_1 \times 5top100 + \beta_2 \times Oporniy + \beta_4 \times OpenPlatform + \beta_5 \times InternalPlatform + \beta_5 \times Dual + \varepsilon,$$

Where *TehUspehnumber* - number of companies in the region included in the rating "TechSuccess", *5top100* - number of universities participating in the program "5-100" in the region, *Oporniy* - number of supporting universities in the region (binary variable, takes the value of 0 or 1), *OpenPlatform* - Number of mass online courses of universities in the region, placed on the international platforms Coursera and edX, *InternalPlatform* - the number of online courses on the internal platforms of the university on the type of Moodle and Sakai, *Dual* - binary variable indicating the participation of the region in the program of implementation of the dual system of secondary special education, ε - random error model.

Results

As Moscow and Saint-Petersburg have high indicators of the number of companies included in the rating "TechSuccess", we consider them as anomalous values for the total population. In order to get reliable results, we select 2 main samples of regions: with the inclusion of Moscow and St. Petersburg and without their participation. In addition to the regions participating in the rating "TechUp", the sample included regions that actively participate in some of the above initiatives of the Ministry of Higher Education and Science. At the same time, the value of the dependent variable for these regions was equal to zero. Thus, the total sample consisted of 46 surveyed regions.

In the first specification, we selected the entire sample of regions and all variables. In the second specification, we excluded Moscow and St. Petersburg from the sample as emissions. In the third specification, we took the entire sample of regions, but excluded the variables "Number of reference universities in the region" and "Participation of the region in the implementation of the dual system of secondary vocational education", as neither Moscow nor St. Petersburg took part in these programs (Table 8).

Table 8. The main results of model 3

	3.1	3.2	3.3
<i>5top100</i>	3,629*** (0,571)	2,018*** (0,569)	3,685*** (0,595)
<i>Oporniy</i>	-1,357* (0,741)	-1,126** (0,523)	
<i>Open Platform</i>	-0,064 (0,131)	-0,066 (0,479)	-0,089 (0,137)
<i>Internal Platform</i>	0,316** (0,153)	-0,165 (0,583)	0,323** (0,159)
<i>Dual</i>	0,889 (0,707)	1,179** (0,502)	
Const	1,059** (0,494)	1,306*** (0,349)	1,000** (0,401)
F-статистика	49,171***	5,934***	73,653***
R ²	0,86	0,43	0,84
Number of observations	46	44	46

The first specification revealed the significance of 5 top 100 variable and the number of online courses available on internal platforms. The significant positive impact of the 5 top 100 program is not surprising, as it involves the best universities in the country.

The significance of the variable online courses posted on internal platforms shows the positive impact of online education on the development of innovative firms in the region. Often these courses are developed within the framework of additional education and are part of the professional development program. They guarantee flexibility for company employees and have a positive impact on the innovation climate in the region.

The insignificant impact of MOOCs available on international platforms can be explained by the fact that they are not open to measuring their impact in the region. Available around the world, these courses can improve the skills of students in any region of the country, so the impact of these courses on specific regions is difficult to measure. The variable representing the supporting universities has a significant negative impact on the number of innovative firms in the region. This can be explained by the fact that the winners of this first wave competition did not originally represent the most developed regions of the country. These statistics may also serve as a signal to review the functions of these universities and increase their application orientation.

The peculiarity of the second specification (without Moscow and St. Petersburg) is the significance of the variable "Participation in the implementation of the dual system of vocational education". The given program has shown its efficiency, and presence of outliers such as Moscow and St.-Petersburg distorted reliability of results of the given

variable, as these regions obviously did not participate in the program. The regression analysis has shown the effectiveness of this program and its great potential for spreading to other regions of the country. At the same time, the variable number of courses on the internal platforms becomes insignificant, which indicates a particularly significant impact of this indicator for Moscow and St. Petersburg.

Conclusion

Despite all the efforts of the government, the share of innovative firms in Russia continues to decline. At the same time the quality of innovative product output remains low. Scientists link the growth resources of the Russian economy at the moment mainly to the development of human capital. Recently, a number of reforms have been introduced to improve the quality of education. However, the assessment of the impact of these reforms on the innovative development of firms in the regions has not yet received extensive attention. This paper improve our understanding of the effectiveness of highly qualified human capital on firms' innovation activity in Russian regions, as well as the effectiveness of the latest reforms of the Ministry of science and higher education of the Russian Federation.

In our study, we set two main goals: to identify the factors that affect the labor productivity of Russian high-tech enterprises, and to reveal the impact of educational policy reforms on the development of regional high-tech companies.

In the first part, we found that highly qualified human capital has a significant positive impact on the productivity of high-tech firms in Russia. Among other factors, we found a significant positive impact of costs on R&D, production of new products, age of the company, location of the company in Moscow or St. Petersburg. However, our research did not confirm the positive significant impact of the number of patents on the production of high-tech firms' workers, which may confirm the fact that Russian patents cannot adequately reflect the innovation activity, due to high proportion of approved applications⁵ and low commercialization of the patents⁶.

The second part of the analysis was devoted to the effectiveness of the latest initiatives undertaken by the Ministry of Higher Education and Science in terms of increasing the innovative activity of regional firms. The regression analysis revealed the significant impact of the leading higher education institutions of the country participating in the 5 top 100 program on the innovative activity of regional firms, as well as the large potential of dual secondary vocational education. Online education also has a positive impact on the innovation activity of regional firms.

Thus, the research in this article showed the great potential of human capital for innovation-active firms, as well as the positive impact of recent reforms of the Ministry of Education and Science on the innovation climate in the regions of the country.

⁵ in 2013 80% of patent applications were approved

⁶ According to the data of the NCB groups in 2012 only 0.14% of the issued patents were commercialized

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Annex

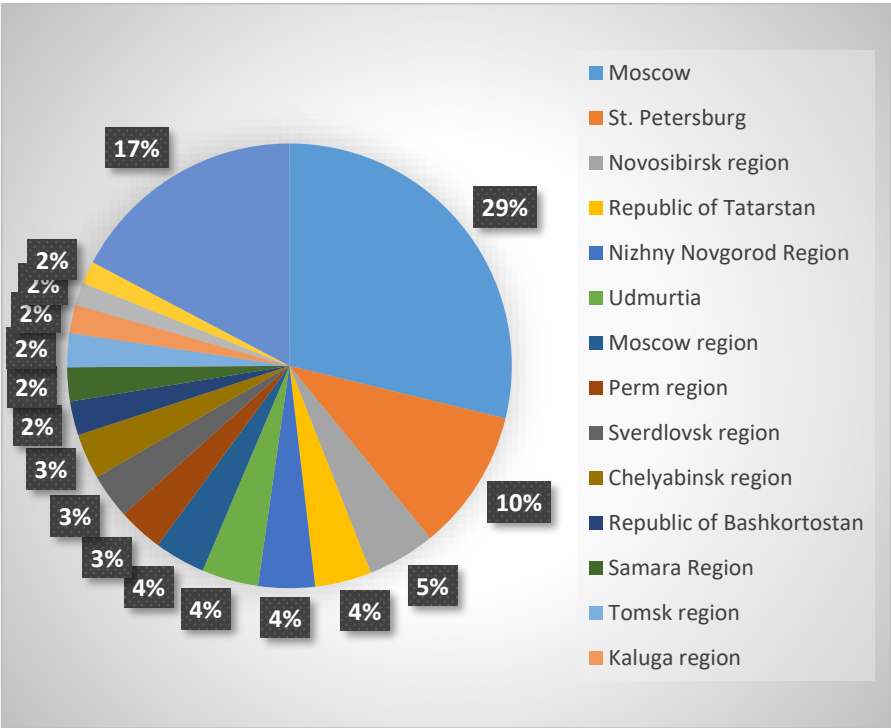


Figure 2 - Regional structure of the sample of "TechUspeh" companies

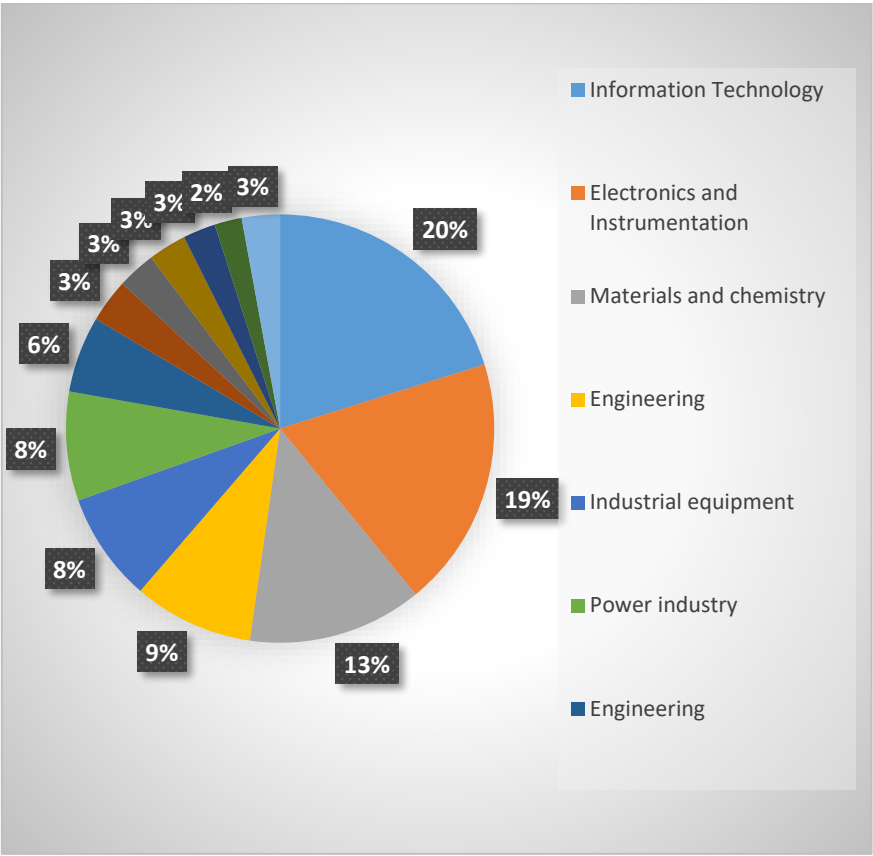


Figure 3 - Sectoral structure of the sample companies rating "TechUspeh"