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DEVELOPMENT OF KAZAKHSTAN'S REGIONAL LABOUR MARKETS IN THE DIGITAL ECONOMY: FACTORS AND CONDITIONS[1]

Abstract. Changes in the labour market are an inevitable result of technological progress. In these circumstances, the effectiveness of public policy will depend on the correct projection of the future balance in the labour market and on the drivers that can affect the technological development, elimination or preservation of jobs. Based on correlation and regression analysis, the study examines the influence of various factors on the transformation of regional labour markets in the context of digitalisation. The conducted calculations revealed that the human capital and entrepreneurial activity in the region influence the labour market the most. The calculated coefficient of elasticity shows that when the share of students in the population increases by 1 %, the value of the variable of the share of IT employees in the total number of employees increases by 0.15 %. Increase in the ratio of small enterprises to the labour force by 1 unit shall increase the share of IT employees in the total number of employees by 0.002 %. However, at present, information and communication infrastructure is not a key factor in the development of labour market and new sectors, expanding opportunities for digital entrepreneurship, as well as online and offline training. Also, region's innovative potential (level of business innovation in the regions by technological innovations) is not a significant indicator of the intensity of development of new economic sectors and the formation of a regional base of accumulated knowledge and competencies. It was concluded that for the developing economy of Kazakhstan, the improvement of information and communication infrastructure based on digital platforms is more rational for the labour market's further development.

Keywords: labour market, regional employment, digital economy, automation risks, digital infrastructure, digitalisation of industries

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Факторы и условия развития региональных рынков труда Казахстана в цифровой экономике

Аннотация. Изменения на рынке труда являются неизбежным результатом технологического прогресса. Эффективность государственной политики зависит от корректного прогноза баланса на рынке труда рабочей силы и от факторов, воздействующих на технологическое развитие, ликвидацию или сохранение рабочих мест. На основе корреляционно-регрессионного анализа проведено исследование влияния различных факторов на трансформацию региональных рынков труда в условиях цифровизации. Расчеты продемонстрировали, что человеческий капитал и предпринимательская активность в регионе оказывают наиболее существенное влияние на рынок труда. Рассчитанный коэффициент эластичности показывает, что при возрастании доли студентов в численности населения на 1 % значение переменной доли работников информационной сферы в общей численности занятых возрастает на 0,15 %. Увеличение показателя «отношение числа малых предприятий к рабочей силе» на 1 единицу приведет к увеличению показателя доли работников информационной сферы в общей численности занятых на 0,002 %. Однако в настоящее время информационно-коммуникационная инфраструктура не является ключевым фактором развития рынка труда и новых секторов, расширения возможностей для цифрового предпринимательства, а также онлайн- и офлайн-обучения. Также не является значимым показателем интенсивности развития новых секторов экономики и формирования региональной базы накопленных знаний и компетенций инновационный потенциал региона (уровень инновационной активности предприятий в регионах по технологическим инновациям). Сделан вывод, что для дальнейшего развития рынка труда развивающейся экономики Казахстана улучшение информационно-коммуникационной инфраструктуры на базе цифровых платформ является наиболее рациональным подходом.

Ключевые слова: рынок труда, региональная занятость, цифровая экономика, риски автоматизации, цифровая инфраструктура, цифровизация отраслей

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Introduction

Beginning with a scientific and technological progress, the fourth industrial revolution has intensified discussions of the labour market's future development in the scientific community. Changes in the labour market are an inevitable result of technological progress. In these circumstances, the effectiveness of public policy will depend on the correct projection of the future balance in the labour market and on the drivers that can affect the technological development, elimination or preservation of jobs.

Before Kazakhstan adopted the State Program Digital Kazakhstan (2017), digital technologies would develop slowly. But even in the conditions of smooth digital transformation of economic sectors at the expense of the huge budget funding and the absence of large-scale technological unemployment in Kazakhstan, risk factors of digitalisation and adaptation of regional labour markets to this process still should be considered.

At the moment, the main risk for digitalisation of production is that it will not be easy for the population to adapt to rapidly changing conditions when the time comes. It is also important that Kazakhstan regions are quite heterogeneous in terms of opportunities to adapt to the digitalisation of the economy.

The purpose of the paper is to analyse the impact of the economic sector's digitalisation on the state of regional labour markets in Kazakhstan and to assess the prospects for adapting regions to digital transformation.

Literature Review

In previous studies (Seitzhanov et al., 2020; Kurmanov et al., 2019; Kurmanov et al., 2016), we concluded that digitalisation of economy and automation of production may have two opposite effects on the labour market development:

— they contribute to an increase in unemployment and a decrease in employment in low and medium skilled sectors of the economy;

— they are basically an additional factor of economic growth and can be a response to the reduction of the labour force in the market.

Let us take a closer look at the factors and conditions that affect the development of the labour market in the digital economy.

In their paper «Industrial Renewal in the 21st Century: Evidence from US Cities», Berger and Frey (2017) note that new professions, fields of activity and industries are constantly emerging and developing in the context of Industry 4.0. In modern conditions, the fastest growing industry in the world is the information technology (IT) sector, which creates new jobs that are least vulnerable to automation.

Results of many studies (Zemtsov, 2018; Zemtsov, 2017; Autor et al., 2003) indicate that the quality of information and communication infrastructure (ICI) in the country is an important factor in the development of new industries and digital transformation of the labour market. The 2016 World Bank report «Digital dividends» (World Bank, 2016) concludes that regions of the world with a developed ICI enjoy extensive opportunities for developing online business and trade, the largest market size of information and communication technologies, as well as the implementation of online and offline. Regions with developed ICI have already established the necessary basis for the formation of new promising sectors of the economy: digital entrepreneurship, telemedicine, virtual reality, etc. Creating and maintaining an enabling environment for new types of industries, companies, and jobs, primarily in the IT sector, shall enable governments to better adapt labour markets to digitalisation in the future.

Analysis of the scientific literature (Acemoglu & Restrepo, 2020; Sorgner, 2019; Fossen & Sorgner, 2019; Kergroach, 2017; Seidl da Fonseca, 2017; Frey & Osborne 2017; Ford, 2009) has allowed us to identify a number of key indicators for the development of the world and national information and communication infrastructure: the existing needs of society, the current state of ICI, the level of integration of related industries and their relationship, and the level of global and internal competition.

1) Existing needs of the society. In accordance with the concepts of the modern economy, the market where there is a growing need for something is a rapid increase in the number of manufacturers, as well as in foreign supplies. Currently, the world centres of consumer demand for information technology are the United States, the European Union, Japan and China. These countries have a considerable number of IT companies operating to meet this need.

2) Current state of ICI. This is actually the starting condition for creating new industries and jobs. It is necessary to take into account the following indicators that characterise the state of ICI: prevalence of personal computers and the Internet among households and businesses; quality and technical condition of communication channels and lines; availability and proper functioning of 5G technology and Integrated Services Digital Network (ISDN) data transmission lines, etc.

3) Level of integration of related industries and their relationship. For information and communication infrastructure, related industries are consumer electronics, telecommunications, computers, creative industries, and mass entertainment.

4) Global and internal competition, the natural result of which is the emergence of world leading producers of ICT. The exclusive role in this process belongs to American companies, which are ahead of similar firms in the EU and Japan. The US information and communication infrastructure is more competitive than the EU due to two factors: availability of networks and low cost of communication services. However, in the modern world, there is not a single company or country that had completely resolved the issues of global or internal competition in IT.

In their paper «Industrial Renewal in the 21st Century: Evidence from US Cities», Berger and Frey (2017) identify key drivers that contribute to changing the structure of the economy of American cities. The authors attribute these changes to the emergence of new sectors and jobs, mainly in IT. The key factors in creating new economic sectors and jobs in cities were as follows: intensity of information technology use; variety of urban activities; flow of new specialists and students. Let us take a closer look at each of these factors.

1) Results of research by Lin (2011) and Beaudry et al. (2010) indicate that in cities with a high proportion of information technology experts among university graduates, jobs are created faster in new sectors of the economy, among which the IT stands out.

2) Back in 1969, a Canadian urban planning theorist Jacobs (1969) identified a leading factor in the city's economic development, the diversity of activities. The key idea of the founder of the new urbanism movement is that the scale and volume of the market of the city (regional centre) provide maximum opportunities for creating new more complex sectors and broad population coverage with new specialties and professions.

3) The basis for the formation and development of promising sectors of the economy are well-trained students. Many young and creative university graduates eventually become innovators and start their own businesses. According to Russian scientist Zemtsov, «it is difficult to expect fast-growing startups and breakthrough solutions in regions where education system trains only a few dozen information technology specialists a year.» (Zemtsov et al., 2019).

It is important to note that in regions where routine work predominates, digitalisation leads to job cuts, while regions with a high proportion of creative professionals enjoy the creation of new sectors, companies and jobs. Prominent foreign scientists like Moretti (2012), Autor and Dorn (2013) confirm these conclusions as well. Interesting is research by Martin (2010), who concludes that «region's specialisation in individual industries can lead to «blocking,» a state in the economy when the entire local community, businesses, and universities focus on the development of one sector». According to Berger and Frey (2017), the dominance of extractive or manufacturing industries in the regional economy negatively affects the formation of new sectors.

Beaudry et al. (2010) and Chen (2012) state that the United States' employment in the IT sector has a direct positive correlation with a significant concentration of people with higher education. Chen (2012) links the distribution of employment in China's IT sector to favourable living conditions. Thus, for the development of new sectors of the economy, it is important not only to train and develop, but also to attract highly qualified personnel. Having analysed the scientific literature, we conclude that human capital in the region is able to concentrate over time. Therefore, this factor should be considered when implementing measures to regulate regional labour markets in the context of the economy digitalisation.

According to Zemtsov et al. (2019) and Berger and Frey (2017), innovative potential of the territory is also a significant factor in creating new sectors and jobs. We can measure it by a number of indicators:

— business innovations;

— number of those engaged in research and development (R&D);

— share of innovative activity costs.

Another important driver of creating new economic sectors is entrepreneurial activity in the region. It reflects the involvement of the local population in the process of developing existing and creating new types of business. A number of scientific papers define entrepreneurial activity as the share of the employed population who run their own businesses. In the publication «An Eclectic Theory of Entrepreneurship: Policies, Institutions and Culture,» Verheul and colleagues define the ratio of the number of small businesses to the labour force as an assessment of entrepreneurial activity (Verheul et al., 2002). We believe that Verheul's concept is more adequate for consideration of the entrepreneurial factor in the formation of new sectors and new jobs than other ones that consider the process of startup emergence. In particular, this indicator takes into account both the involvement of local population in entrepreneurship and the conditions for registering a firm.

The analysis of the scientific literature allows us to formulate a number of hypotheses:

Hypothesis 1. Employment in the IT industry is lower in Kazakhstan regions where routine and manual labour predominates.

Hypothesis 2. Favourable conditions for business development and high entrepreneurial activity in the region create a stable basis for the emergence of promising economy sectors, contributing to the emergence of new competencies and professions.

Hypothesis 3. In large cities with large-scale markets and a wide variety of activities, opportunities for new industries and new jobs are better.

Hypothesis 4. Development of new economic sectors depends on the human capital generated in the region: a high level of education creates opportunities for learning, mastering new activities and emerging technologies.

Research Data and Methods

Reducing the risks of industrial automation and increasing the adaptability of Kazakhstan's regional labour markets to digitalisation is possible in favourable conditions for the formation of new economic sectors, mainly in the information technology sector. In this regard, we shall use the indicator of the share of IT employees in the total number of employees as a dependent variable in the empirical model. In other words, we study IT's role in the functioning of labour markets and the development of the digital economy elements in the regions of Kazakhstan.

Table 1

Economic and mathematical model: Factors and variables

Legend	Factors	Legend	Variables	Source
1	2	3	4	5
Diversity_activ	Diversity of regional activities	*Reg_popul*	Population in regional centres, thousand people	BNS
Human_Capital	Human capital of the region	*Emp_popul*	Employed people in regional economy, thousand people	BNS
		Educ_Emp	Share of the employed population with higher education, %	BNS
		Stud_popul	Share of students in population, %	BNS
ICT	ICT of the region	*Internet1*	Share of households with internet access, %	BNS
		Internet2	Share of enterprises using the Internet, %	BNS
Business	Conditions for regional business development	*Firm*	Number of small enterprises / labour force ratio, per ten thousand people	BNS
Innov_poten	Innovation potential of the region	*Innov*	Level of innovation activity of enterprises in regional technological innovations, %	BNS
EconSpecial	Features of the regional economy structure	*Agro_Emp*	Share of population employed in agriculture	BNS

Notes:
1) Compiled by the authors
2) BNS — Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.

According to the Committee on Statistics of Ministry of National Economy of the Republic of Kazakhstan, the share of IT workers in the total number of employees in 2018 was 1.9 % or about 166.5 thousand.

In 2018, the largest share of IT experts in the total number of employees in Kazakhstan was concentrated in the following regions:

— Astana (4.4 %);
— Almaty (3.9 %);
— Shymkent (3.0 %);
— East Kazakhstan region (2.1 %);
— Mangistau region (1.9 %).

In these regions, the share of IT experts in the total number of employees is higher than the national average of 1.9 %. The smallest share of IT experts is in Zhambyl (0.6 %), Kyzylorda (0.8 %) and Akmola (0.8 %) regions.

In the period of 2010–2018, most regions enjoyed positive dynamics in the number of IT experts. However, in Akmola, Zhambyl, Karaganda and Kyzylorda regions, the number of IT experts decreased during the same period. We believe that this may be an indicator of negative phenomena in the social sphere and economy of these regions: a «brain drain», low material assessment of intellectual labour, etc.

We have selected the following variables as independent indicators affecting the dynamics of the share of IT employees in their total number:

1) variety of activities with the population in regional centres, thousand people.

2) human capital of the region:

— number of employed population in regional economy, thousand people;

— share of employed population with higher education, %;

— share of students in the population 10 years ago, %.

3) ICT of the region:

— share of households with Internet access, %;

— share of organisations using the Internet, %.

4) conditions for business development in the region: the ratio of the small enterprises to the labour force, per 10 thousand people.

5) innovation potential of the region: level of business innovation in the regions by technological innovations, %.

6) control variable, the proportion of those employed in agriculture.

The control variable describes features of the regional economy structure: share of people employed in agriculture, a sector that actively uses manual and routine labour, i. e. minimal opportunities for creating new industries and implementing information technologies. Table 1 shows the main factors and variables used in the economic and mathematical model.

We propose the following empirical model to test the hypotheses put forward:

$$Info\_work_{it} = \alpha Diversity\_activ + \beta Human\_Capital_{it} + \gamma ICT_{it} + \delta Business_{it} + \lambda Innov\_poten_{it} + \mu EconSpecial_{it} + \varepsilon_{it} \quad (1)$$

where *Info_work* is the share of IT employees in the total number of employees (%); *Diversity_ac-*

tiv is the diversity of activities in regions; *Human_Capital* is the human capital of the region; *ICT* is the ICT of the region; *Business* is the conditions for business development in the region; *Innov_poten* is the innovation potential of the region; *EconSpecial* is features of the regional economy structure; *i* is the region; *t* is the year.

All indicators are courtesy of official sources of the Committee on Statistics of Ministry of National Economy of the Republic of Kazakhstan. We also used panel data with fixed effects to build the model.

Results and Discussion

The simplest way to visualise the presence (or absence) of relationships and check their nature between variables is to plot the scattering (Figures 1, 2).

Analysis of the scatter plots revealed the absence of relationship between the indicator of the share of IT employees in the total number of employees with the following independent variables:

— number of employed people in regional economy;

— share of households with Internet access;

— share of organisations using the Internet;

— level of business innovation in the regions by technological innovations.

The indicator of the share of IT employees in the total number of employees has a positive correlation with such variables as:

— population of regional centres;

— share of employed population with higher education;

— share of students in the population;

— ratio of the number of small enterprises to the labour force.

Correlation between the variables of the share of IT employees in the total number of employees and the share of those employed in agriculture is negative.

Variables displayed on scatter plots are of linear dependence, which will allow us to construct a linear multiple regression equation in the future.

The high determination coefficient of 84 % in the *Educ_Emp* graph indicates that only 16 % of the variation in the independent variable is not related to the share of employed population with higher education.

We used a correlation coefficient to verify the results of the analysis of scatter plots and to estimate the tightness between variables. The result was the following correlation matrix (Table 2).

Analysis of the correlation matrix has shown that the share of IT employees in their total number has:

— a very high correlation with the share of employed population with higher education (0.92);

— a high correlation with the ratio of the small enterprises to the labour force (0.84), the population in regional centres (0.82), and the share of students in the population (0.8);

— an average negative correlation with the independent variable *Agro_Emp*, the share of those employed in agriculture (0.65);

— a weak correlation with the share of households with Internet access (0.23).

At the same time, we observe a very weak correlation with the following indicators:

— level of business innovation in the regions by technological innovations (0.4);

— share of organisations using the Internet (0.12);

— number of employed people in regional economy (0.14).

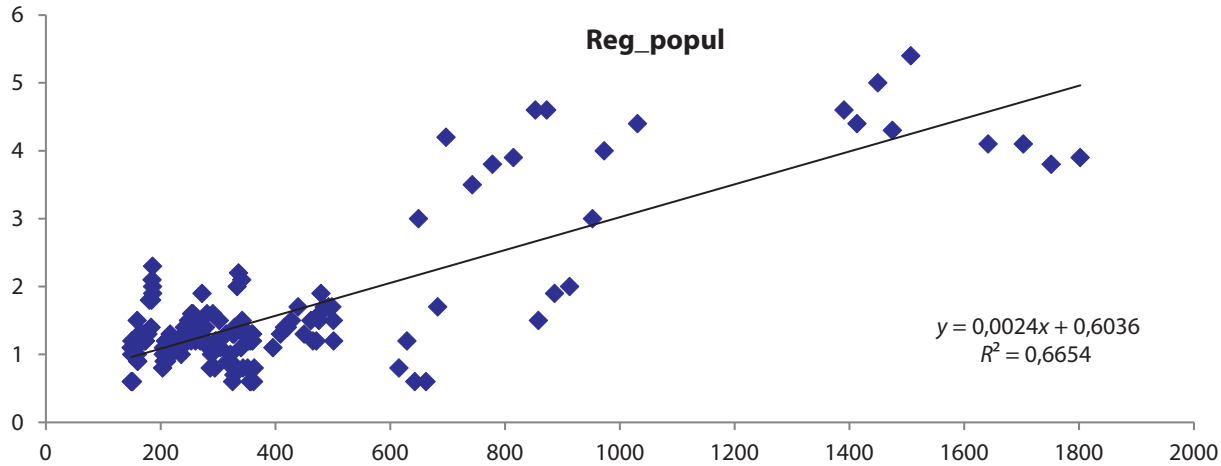
We will not consider these indicators in our future studies due to their very weak correlation with the independent variable.

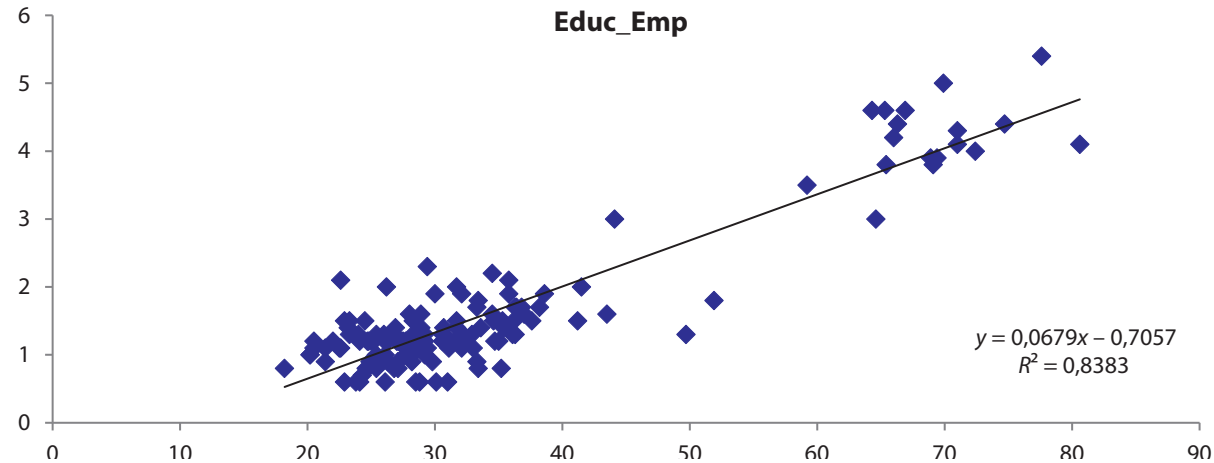
The analysis of the correlation matrix has also shown that there is a close correlation between the share of employed population with higher education with all changes (a multicollinearity), which

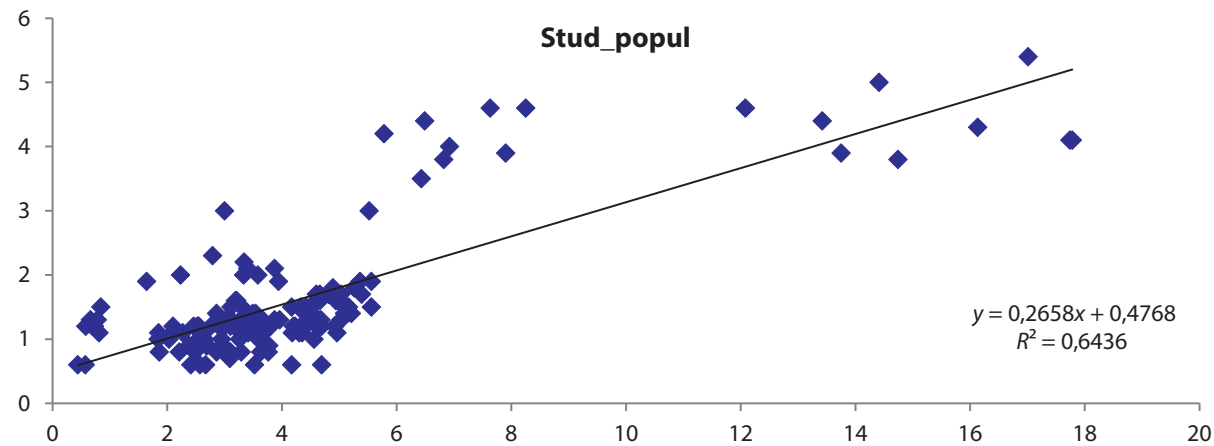
Table 2

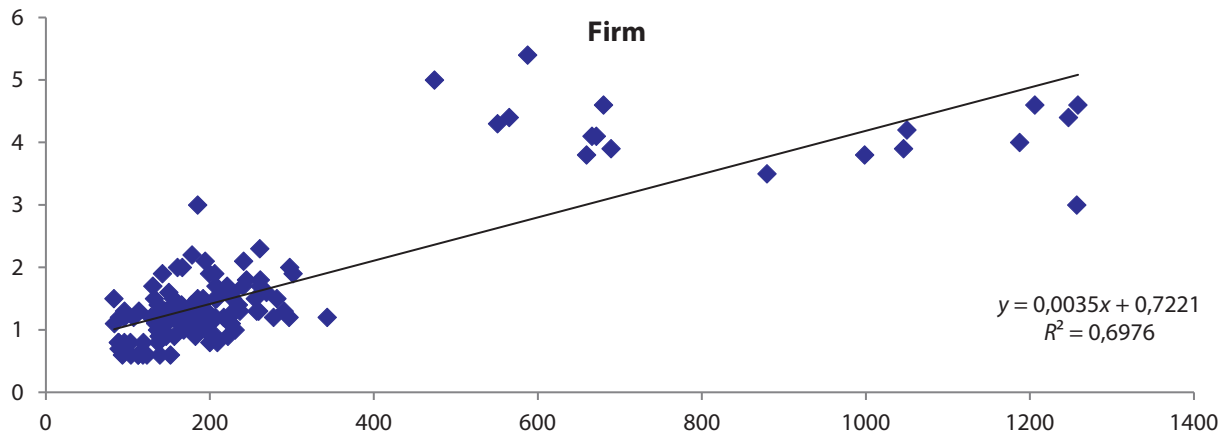
Correlation matrix

	Info_work	*Reg_popul*	*Emp_popul*	*Educ_Emp*	*Stud_popul*	*Internet1*	*Internet2*	*Firm*	*Innov*	*Agro_Emp*
Info_work	1.00									
Reg_popul	0.82	1.00								
Emp_popul	0.14	0.43	1.00							
Educ_Emp	0.92	0.84	0.15	1.00						
Stud_popul	0.80	0.89	0.15	0.82	1.00					
Internet1	0.23	0.14	–0.02	0.33	0.15	1.00				
Internet2	0.12	0.12	–0.18	0.08	0.18	0.18	1.00			
Firm	0.84	0.61	–0.07	0.85	0.57	0.22	0.08	1.00		
Innov	0.04	0.05	0.02	0.09	–0.02	0.32	0.31	0.11	1.00	
Agro_Emp	–0.65	–0.49	0.17	–0.67	–0.54	–0.41	–0.09	–0.58	0.00	1.00









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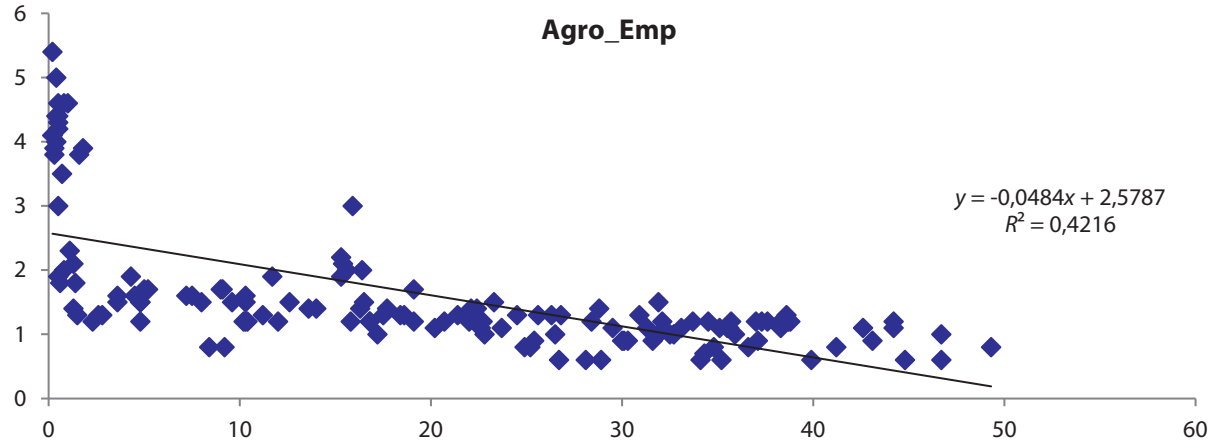
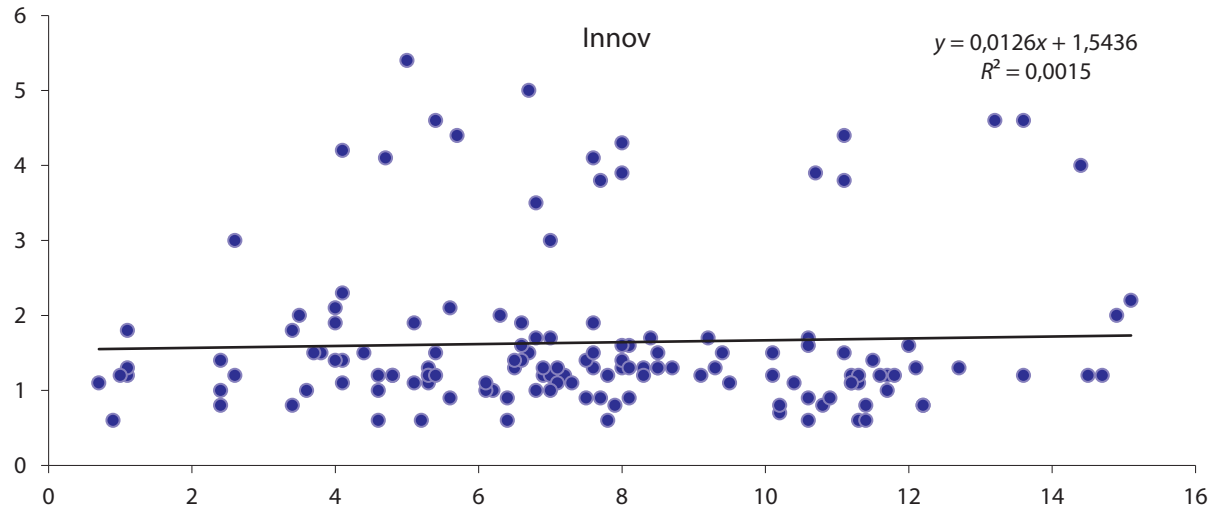
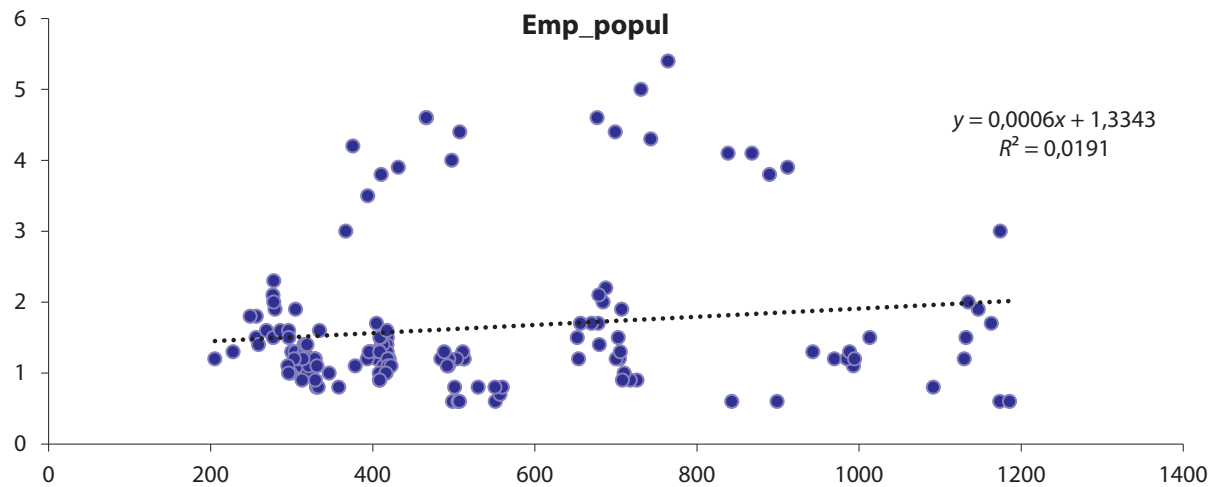


Fig. 1. *Scatter plots between independent and dependent variables (the correlation between variables is present)*





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eliminates the possibility of including this factor in the regression model. Indicators of the pair correlation of the number of employed people in regional economy and the share of students in the population have similar values, i. e. they depend on each other. In this regard, we have selected one factor, namely *Stud_popul*, for further building of the regression model.

Then, using the application for econometric analysis SPSS and Excel, we have calculated the parameters of correlation and regression analysis. Table 3 shows the results of correlation and regression analysis.

Table 3 shows that the correlation coefficient $R = 0.92$. This indicates a close linear relationship between the parameters of the regression model.

End Figure 2

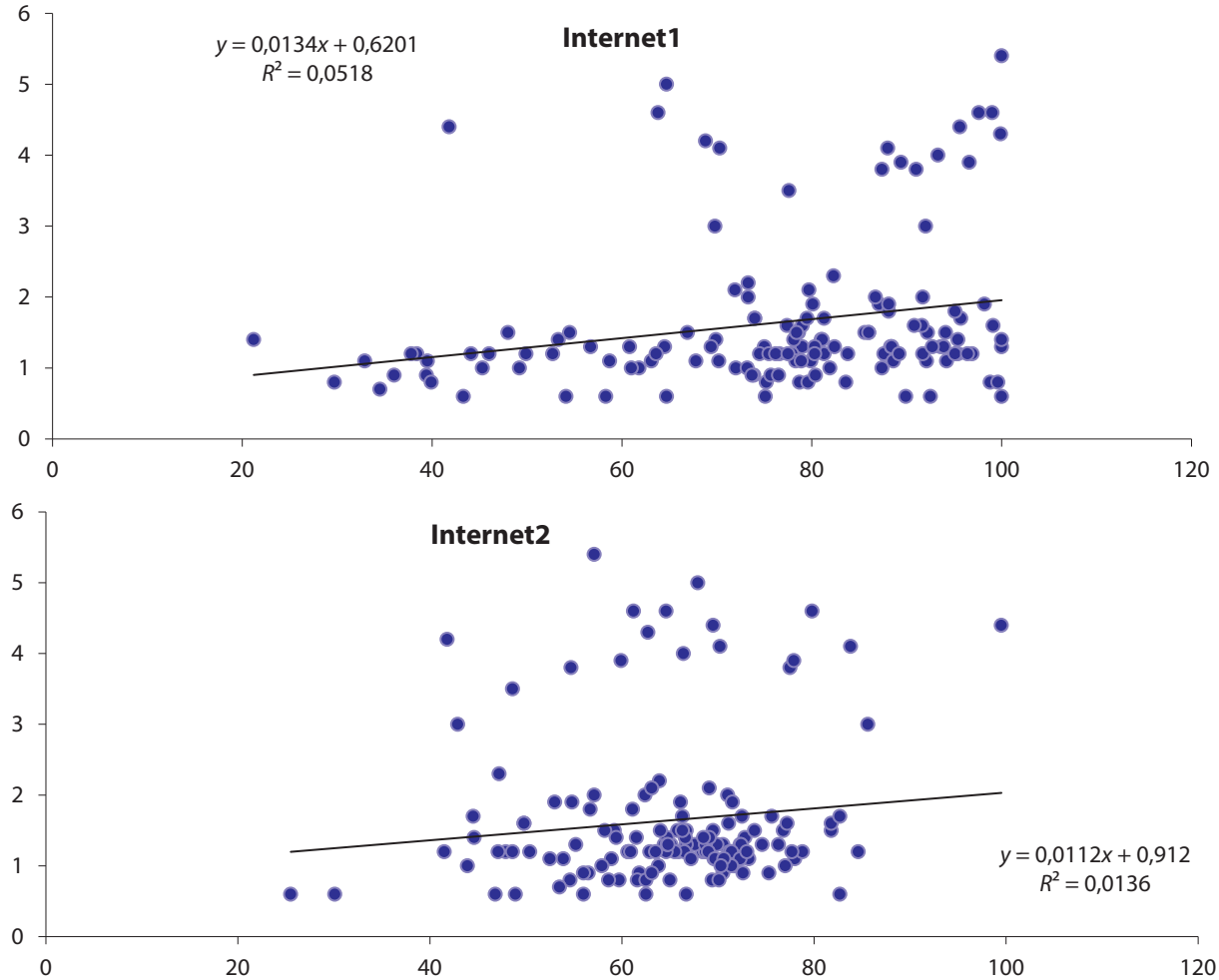

Fig. 2. *Scatter plots between independent and dependent variables (correlation between variables is weak or absent)*

The coefficient of determination r^2 = 0.86 shows that the linear multiple regression equation is explained by 86 % of the variance in the influence of independent variables, and the share of other factors of influence on the share of IT employees in the total number of employees accounts for 14 %.

The general view of the model can be represented by a linear multiple regression equation:

Table 3

Results of correlation and regression analysis

Regression statistics					
Multivariate *R*	0.92777389				
R-square	0.860764391				
Normalised *R*-square	0.857780771				
Standard error	0.398762356				
Observation	144				
Variance analysis					
	df	*SS*	*MS*	*F*	*F signification*
Regression	3	137.6227767	45.87425889	288.4966367	1.01807E-59
Excess	140	22.26159833	0.159011417		
Total	143	159.884375			
	Coeff	Standard error	*t*-statistics	*P*-Value	
Y-intersection	0.597472478	0.110435925	5.410127872	2.65498E–07	
Stud_popul	0.147699829	0.013407576	11.01614715	1.0327E–20	
Firm	0.002126502	0.000173439	12.26083386	6.23669E–24	
Agro_Emp	–0.0086232	0.00302238	–2.85311562	0.0049865	

$$Info\_work_{it} = 0.5974 + 0.1476\ Stud\_popul_{it} + \\ + 0.002\ Firm_{it} - 0.008\ Agro\_Emp_{it} \quad (2)$$

where *Info_work* is the share of IT employees in the total number of employees (%); *Stud_popul* is the share of students in the population 10 years ago, %; *Firm* is the ratio of the small enterprises to the labour force, per 10 thousand people; *Agro_Emp* is the share of people employed in agriculture, %; *i* is the region; *t* is the year.

Assessment of the quality of a linear multiple regression equation using the Fischer criterion (*F*-criterion) allows us to recognise the statistical significance of the equation:

$$F = 228.5;\ F_{table.} = 2{,}61\ (F_{fact} > F_{table}) \quad (3)$$

We have calculated the student's *t*-test to assess the statistical significance of both correlation and regression coefficients, as well as the confidence intervals of each of the indicators. Table 3 data demonstrates that the actual values of *t*-statistics:

$$t_a = 5.41;\ t_b = 11.01;\ t_c = 12.26;\ t_d = -2.85 \quad (4)$$

have shown the statistical significance of regression model parameters and communication tightness indicator (modulo $t_a > t_{table}$, $t_b > t_{table}$, $t_c > t_{table}$, $t_d > t_{table}$).

Conclusions and Policy Implications

The regression model we have built allows us to conclude the following:

— when the share of students in the population increases by 1 %, the value of the variable of the share of IT employees in the total number of employees increases by 0.15 %;

— increase in the ratio of small enterprises to the labour force by 1 unit shall increase of the share of IT employees in the total number of employees by 0.002 %;

— a 1 % reduction in the share of people employed in agriculture will lead to an increase in of the share of IT employees in the total number of employees by 0.008 %.

Calculations we have made and the regression model we have built did not allow to refute any of the research hypotheses put forward. We have confirmed the importance of factors described in the scientific literature for the development of new sectors and the adaptation of labour markets to the processes of digitalisation and automation. In the current socio-economic conditions, the most significant factors for the formation and development of new sectors of Kazakhstan's economy, as well as creation of conditions and opportunities for creative implementation of professionals are as follows:

— large-scale labour market and a variety of professions in a major city;

— high concentration of human capital (the share of employed population with higher education, the share of students in population);

— conditions for business development in the region (ratio of small enterprises to the labour force).

We have not confirmed the assertion that the basic factor of IT progress in regions is the developed information and communication infrastructure. According to the international company Website Tool Tester, in 2019, Kazakhstan would rank 113th out of 207 countries in terms of Internet speed. The rating assessed three indicators: download speed; changes in Internet speed; and state spending on Internet development in recent years. Kazakhstan is also experiencing an issue of digital inequality in Internet access between regions and localities. It is better near the cities of national significance and regional centres, but remote localities still have no high-quality Internet access. Thus, we conclude that the information and communication infrastructure of Kazakhstan needs further development. Currently, it is not a key factor in the formation and development of new sectors, expanding opportunities for digital entrepreneurship, as well as online and offline training. This is also confirmed by a weak correlation between the share of IT workers in the total number of employees and the share of households with Internet access (0.23).

Also, the innovation potential of the region (level of business innovation in the regions by technological innovations) is currently not a significant indicator of the intensity of development of new economic sectors and the formation of a regional base of accumulated knowledge and competencies. This is confirmed by the findings in a number of Kazakh academic sources, in particular, the low number of R&D employees, a low share of innovation costs, the lack of demand for innovations, the lack of high-tech businesses and the number of patents. The direct dependence of accumulated knowledge and skills at the regional level on the development of new sectors and activities has long been proven. Thus, there is a strong correlation between ICT and the number of people engaged in R&D at the regional level. In the United States, concentration of research colleges and students heavily affects employment in the technology sector. We believe that the development of innovation and innovation potential in Kazakhstan needs special attention when forming and implementing state and regional policies.

A significant share of agriculture (routine and manual labour) in the structure of gross regional product does not contribute to the formation and development of new economic sectors in it.

In current conditions, the key direction of development of Kazakhstan's regional labour markets in the context of the economy digitalisation is the creation of digital platforms.

In our further research, panel data shall reveal differences in the functioning and development of the labour market in Kazakhstan regions and help formulate theoretical and methodological provisions for the formation of digital platforms.

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