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The Impact of Technological and Socio-Economic Factors on Personnel Security Elements of the Region



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Abstract

Introduction. In conditions of instability, regions face the problems of population outflow, declining quality of labor resources, and growing imbalance in the labor markets. The solution of these systemic problems is of strategic importance for maintaining human resources and national security as a whole. The development of effective mechanisms to ensure personnel security of the region is impossible without an objective assessment of its internal reserves on the basis of economic and mathematical modeling. Due to the relative novelty of the category "personnel security of the region" in the domestic scientific literature there are no studies on the data of the subjects of the Russian Federation on the relationship between the indicators of technological and socio-economic development with the indicators of personnel security, which limits the possibility of developing sound recommendations for the management of regional systems in the context of modern personnel and demographic challenges. The purpose of the article is to assess the impact of socio-economic and technological factors on the elements of personnel security of the region.
Materials and Methods. The research material was statistical data on socio-economic and technological development of 85 subjects of the Russian Federation for the period from 2017 to 2022. The main method of work is regression analysis. The method of end-to-end regression and panel data methods with fixed and random effects were used. Based on the literature review, we selected dependent variables – elements of human resources security (wages, unemployment rate and the number of the outgoing population) and formulated six hypotheses about the relationship between these variables and technological and socio-economic factors of regional development.
Results. The hypotheses about the positive relationship between investment in fixed capital, introduction of technological innovations and wages; about the negative relationship between the factors of socio-economic and technological development and unemployment; about the positive relationship between the number of crimes and unemployment; about the negative relationship between the factors of investment, accessibility of higher education and the number of outgoing population were confirmed. The hypotheses about the relationship between the elements of personnel security and the factors of education accessibility were partially confirmed.

Discussion and Conclusion. The elements of personnel security are mainly influenced by socio-economic factors, while no significant relationship between technological factors and elements of personnel security was revealed. The obtained results expand the theoretical and empirical base of research on the factors of personnel security of regions, socio-economic and technological development; they will be useful in terms of making complex decisions in the field of investment, innovation and socio-economic policy to ensure personnel security of the region.

Keywords: personnel security of the region, threats to personnel security, regression analysis, human resources, sustainable development, socio-economic development strategy, labor market

Conflict of interest. The authors declare no conflict of interest.

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Влияние технологических и социально-экономических факторов на элементы кадровой безопасности региона

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Аннотация

Введение. В условиях нестабильности регионы сталкиваются с проблемами оттока населения, снижения качества трудовых ресурсов, растущим дисбалансом на рынках труда. Решение этих системных проблем приобретает стратегическое значение для поддержания кадровой и национальной безопасности в целом. Разработка эффективных механизмов обеспечения кадровой безопасности региона невозможна без объективной оценки его резервов на основе экономико-математического моделирования. В силу относительной новизны категории «кадровая безопасность региона» в отечественной научной литературе не представлены исследования на данных субъектов Российской Федерации о взаимосвязях показателей технологического и социально-экономического развития с индикаторами кадровой безопасности, что ограничивает возможность выработки обоснованных рекомендаций для управления региональными системами в условиях современных кадровых и демографических вызовов. Целью статьи является оценка влияния социально-экономических и технологических факторов на элементы кадровой безопасности региона.

Материалы и методы. Материалом исследования послужили статистические данные о социально-экономическом и технологическом развитии 85 субъектов Российской Федерации за период с 2017 по 2022 год. Основным методом работы выступает регрессионный анализ. Использованы метод сквозной регрессии и методы панельных данных с фиксированными и случайными эффектами. На основе литературного обзора отобраны зависимые переменные – элементы кадровой безопасности (заработная плата, уровень безработицы и количество выбывшего населения) и сформулированы шесть гипотез о взаимосвязи названных переменных с технологическими и социально-экономическими факторами регионального развития.

Результаты исследования. Подтверждены гипотезы о положительной взаимосвязи инвестиций в основной капитал, внедрения технологических инноваций и заработной платы; количества преступлений и безработицы; об отрицательной взаимосвязи факторов социально-экономического и технологического развития с безработицей; факторов инвестиций, доступности высшего образования и количества выбывшего населения. Гипотезы о взаимосвязи элементов кадровой безопасности и факторов доступности образования были подтверждены частично.

Обсуждение и заключение. На элементы кадровой безопасности в основном влияют социально-экономические факторы, в то время как существенной взаимосвязи технологических факторов и элементов кадровой безопасности выявлено не было. Полученные результаты расширяют теоретическую и эмпирическую базу исследований о факторах обеспечения кадровой

безопасности регионов, социально-экономического и технологического развития; будут полезны в части принятия комплексных решений в области инвестиционной, инновационной и социально-экономической политики в интересах укрепления кадровой безопасности региона.

Ключевые слова: кадровая безопасность региона, угрозы кадровой безопасности, регрессионный анализ, человеческие ресурсы, устойчивое развитие, стратегия социально-экономического развития, рынок труда

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Introduction. Managing the elements of personnel security in the region, in particular population, human capital, labor market, migration, unemployment and etc., will allow achieving the goals of sustainable development: reduce poverty and inequality in the regions [1], ensure economic growth and innovation development [2]. The factors that any country faces in the field of human resources management such as the decline in quality and depreciation of human capital [3], demographic crisis, “brain drain”, are associated with global changes in the world, changes in cultural and technological patterns [4]. These factors can be identified as the regional personnel security threats, which is related to national security [5].

Russian regions are faced with a number of cases, the solution of which is related to building a long-term strategy for human resource management. According to the Federal Statistics Service, in 2023, only 22 out of 85 regions of the Russian Federation experienced population growth. Of these, 7 regions grew due to both natural and migration, 5 grew naturally, and 10 grew as a result of migration[1]. To address the demographic crisis, a range of financial measures have been implemented at both the federal and regional levels in the form of national projects aimed at supporting vulnerable segments of the population[2]. Simultaneously, the observed effects of changes in both the size and structure of the population, expressed in a decrease in fertility rates and an increase in the aging of the population, lead to a transformation of the labor market [6]. Migration and the senior population are becoming important factors in ensuring the economic growth of regions.

Considering the diverse spatial development of regions in the Russian Federation [7], it may not be effective to use the same human resources management measures to ensure personnel security. Therefore, it is necessary to use a scientific approach to identify threats to personnel security by quantitatively assessing the interrelationship between social, technological, and economic processes in the region.

In research on personnel security, the authors extensively used statistical methods. O. Ryazanova, A. Timin, A. Kotandzhyan [8], E. Maksyutina [9], M. Kudriashova et al. [10] analyzed the dynamics of personnel security indicators and calculation of growth rates.

[1] Population and migration of the Russian Federation 2023 : Bulletin // Federal Statistics Service. Available at: https://rosstat.gov.ru/compendium/document/13283 (accessed 20.11.2024).

[2] Current solutions for fertility support: family policy // The Federation Council of the Federal Assembly of the Russian Federation. Available at: http://council.gov.ru/activity/activities/parliamentary/149964/ (accessed 20.11.2024).

A. Yu. Lukyanova et al. used the index method and methods of averages for calculation of an integral value of personnel security [11]. The authors of the study, N. Kuznetsova and A. Timofeeva, used content analysis techniques to identify and categorize threats to personnel security [12]. They also used statistical methods to analyze the results of surveys conducted with experts, and a hierarchical factor analysis model to understand the relationships between different threats to personnel security [12].

We suggest that econometric methods are underrepresented in studies on personnel security. To conduct a more in-depth analysis of the current state of regional personnel security, it would be necessary to investigate the relationship between indicators of personnel security and regional social and technological developments. Therefore, the aim of the article is to assess the impact of technological and socio-economic factors on regional personnel security elements.

Literature Review. Due to the significant role of human resources in the sustainable economic development of countries and regions, a considerable amount of research has been conducted on the issue of human resource management. Since the 18th century, economists have been studying the role of human resources in economic growth and technological progress. This led to the development of human resource management, human capital and human development theories in the mid-20th century[3]. In modern researchers H. Saleh, B. Surya, D. N. Annisa Ahmad, D. Manda examined the role of human resources in regional development and emphasized the importance of optimizing natural, human, and cultural factors, as well as the development of an investment policy to achieve economic growth in developing regions [13]. Authors Z. Khan, M. R. Hossain, R. A. Badeeb and C. Zhang, also studied the issue of optimizing the management of natural resources and human capital in relation to the development of green technologies for economic growth in countries [14]. D. Gallardo-Vázquez and J. A. Folgado-Fernández investigated the role of universities as a driver of innovation and technology transfer, as well as a source of qualified professionals for local economic actors [15]. In conditions of uncertainty in the influence of both internal and external factors, decisions on the development of human and labour potential can be made more effectively through the use of a risk-based approach. This approach underlies the concept of personnel security.

In modern scientific researches, there is no unified way to defining the "personnel security" at the macro level. First of all, personnel security is studied as an element of the economic security system [16]. Personnel security is defined as the state of the labor market necessary for the sustainable development of the regional socio-economic system [10]. "Personnel security" is also considered as a "process" of preventing challenges and threats in the field of human resource management and labor relations management [9], or as "processes" aimed at minimizing risks and neutralizing threats in the field of personnel management, human resources and human potential, as well as possible destructive trends [17]. In contrast to the theory of human resource management, researchers noted the lack of attention paid to the study of the concept of personnel security on the regional level. The concept of personnel security takes into account the uncertainty of the environment in which socio-economic processes occur, and focuses on potential threats to human resources management in a region that could

[3] Nadezhina O., Avduevskaya E. Genesis of Human Capital Theory in the Context of Digitalization // Conference Proceeding of the 22nd European Conference on Knowledge Management (ECKM). 2021. Pp. 577–584. Available at: https://clck.ru/3LQzcN (accessed 10.03.2025).

hinder the achievement of social and economic development objectives. The concept of personnel security, in contrast to the theory of human resource management, addresses the problem of the influence of the human factor on the interests of the organization, region, country[4]. The authors of the research use the concepts of "threats", "risks" and "damage" caused by the destructive effects of threats to personnel security and note the specifics of the subject-object relations of personnel security [18].

We assume that the personnel security of the region is a complex socio-economic phenomenon. Therefore, we agree with the position M. Kudriashova et al. [10], that the personnel security of the region can be expressed through the category of state, but we believe that it is much broader than the labour market. In our opinion *personnel security* is a state of resilience of the regional socio-economic system that allows it to function sustainably and develop, providing conditions for the reproduction of human resources, in order to counter internal and external threats and successfully adapt to potential negative events.

The methods of assessing the level of personnel security are based on sets of indicators, mainly characterizing demographic, as well as socio-economic and technological processes directly or indirectly related to human resources. For example, O. Ryazanova, A. Timin, A. Kotandzhyan [8] propose to assess the level of personnel security through safety indicators in the field of employment (unemployment rate, demographic load factors, etc.), in the field of labor efficiency, characterizing wages and productivity, and safety of working conditions. E. Maksyutina [9] offers a methodology for assessing personnel security through indicators divided into six groups: indicators of the demographic development of the region, the state of the labor market, social stratification and poverty assessment, education and training, public health, innovative development and the digital environment. N. V. Kuznetsova, A. Yu. Timofeeva [12] argue that in order to comprehensively assess the external and internal environment of a region and identify factors that could disrupt personnel security, it is crucial to identify potential threats. We agree with this viewpoint and believe that indicators related to threats in areas such as migration and human resource management in a region could be used as elements of a framework for personnel security.

To assess the impact of technological and socio-economic factors on the elements of personnel security using econometric methods, we selected three dependent variables: the Average monthly nominal accrued wage; Unemployment rate and Number of departures of the population (migration). Wages are a measure of the standard of living for the population. O. Ryazanova, A. Timin, A. Kotandzhyan used the nominal salary as an indicator in the personnel security assessment system to measure motivation to work [8]. Wages are also related to human capital: low wages may indicate inefficiency and uncompetitiveness of labor resources and according to N. V. Kuznetsova, A. Yu. Timofeeva [12] it is a threat to personnel security.

I. A. Antipin, E. A. Shishkina [19] and O. Ryazanova, A. Timin, A. Kotandzhyan [8] used the "unemployment rate" indicator to analyse the state of the regional labour market in the context of assessing the level of personnel security.

[4] Borovskikh N. V., Kipervar E. A. Threats and indicators of personnel security of the state, region and enterprise // Conference Proceeding Socio-Economic Problems and Prospects for the Development of Labor Relations in the Innovative Economy. Omsk State Technical University. Omsk, 2018. Pp. 14–20. https://www.elibrary.ru/uuylam

The authors of many studies consider migration to be an important element of personnel security [8–10]. On the one hand, migration growth is a factor of economic development in conditions of limited resources [8]. On the other hand, A. P. Sukhodolov, T. G. Ozernikova and N. V. Kuznetsova noted the role of migration outflow of the population from the region as a threat to the personnel security [20]. Due to the negative effects of the migration outflow, we can regard this indicator as a threat to personnel security.

As independent variables (regressors) were selected factors with statistical observations by regions of Russia which in the scientific community are called risk factors and threats to personnel security [4; 21]. We also selected indicators characterizing the current structure of the economic development of the regions of Russia, which have an impact on the indicator of economic security [22]. The variables were divided into two groups: the first group includes factors of technological development of the economic entities of the region, including factors of development and dissemination of ICT and innovations. The second group includes socio-economic factors characterizing the development of the education system in the region, the number of registered crimes, migration processes, investments in fixed assets, as well as factors characterizing the structure of the region's economy.

We assumed that investment growth is positively correlated with economic growth [23] and, consequently, with wage growth and negatively correlated with unemployment [24; 25] and the desire of citizens to leave the region. International studies show that increased foreign investment has a positive effect on wages and reduces income inequality between countries[5]. We also assume that an increase in the availability of higher and secondary vocational education is positively associated with an increase of wages and quality of life in general [26–28].

Research shows that technology has a positive impact on wages, and companies that are inclined to invest in technology pay higher wages [29; 30]. Taking into account the previously obtained results on the impact of regional specialization on economic growth [22], we also assume a stronger positive impact of the extractive sector on wages and a negative impact on unemployment. Also, we suggest about negative impact of this factor on variable "Number of departures of the population" because the regions specializing in mining are a point of attraction for people who want to increase their income.

There is a discussion in research on the impact of technological factors on unemployment. On the one hand, new technologies have a positive effect on employment in high-tech industries [31]. On the other hand, heterogeneous development of innovations in certain circumstances can stimulate the growth of unemployment [32; 33]. Some studies suggest that the impact of innovation on unemployment is insignificant [34].

The authors of the study [35] provide a large literature review proving the positive relationship between fears of migration phenomena and number of crimes, as well as unemployment and number of crimes. The results of their study, as well as research[6], confirm these relationships.

[5] Gopinath M., Chen W. Foreign Direct Investment and Wages: a Cross-Country Analysis // The Journal of International Trade and Economic Development. 2003. Vol. 12, no. 3. Pp. 285–309. https://doi.org/10.1080/0963819032000132067

[6] Wang X., Shixin Hu. Analysis of the relationship between unemployment and crime rate in China // Proceedings of the 2021 International Conference on Social Development and Media Communication (SDMC 2021). 2022, Atlantis Press. Pp. 665–670. https://doi.org/10.2991/assehr.k.220105.122

According to the results of the literature review, we formulated 6 hypotheses of the study:

H1. Investment is positively correlated with average monthly nominal accrued wage and negatively correlated with unemployment rate and number of departures of the population;

H2. Increase in the availability of higher and secondary vocational education is positively correlated with an increase in average monthly nominal accrued wage and negatively correlated with unemployment rate and number of departures of the population;

H3. Technology development is positively correlated with average monthly nominal accrued wage;

H4. Regional specialization on extractive sector has a positive impact of the on average monthly nominal accrued wage and a negative impact on unemployment and number of departures of the population;

H5. New technologies have a positive effect on employment;

H6. There is the positive relationship between number of crimes and number of departures of the population, as well as unemployment and number of crimes.

Materials and Methods. The data for the study were collected from open sources Federal Statistics Service. There were collected 510 observations by 85 regions of the Russian Federation for 2017–2022. For variables expressed in value units ($NWage_{it}$, IFA_{it}), we excluded the influence of the price factor (inflation) thus values are given by 2017. The list of factors for regression modelling is presented in Table 1.

Table 1. **List of factors for regression analysis**

Description	Designation	Unit of measurement
1	2	3
Average monthly nominal accrued wage in constant price (2017)	$NWage_{it}$	*Rubles*
Unemployment rate	$Unempl_{it}$	%
The number of departures of the population per 10 thousand people	$Left\_man_{it}$	Number of people
Technological factors		
The proportion of organizations that used personal computers as a percentage of the total number of surveyed organizations	$Org_{pk_{it}}$	%
The proportion of organizations that used the Internet as a percentage of the total number of surveyed organizations	$Org_{web_{it}}$	%
The share of innovation costs in the total volume of goods shipped, works performed, and services	$Exp_{inov_{it}}$	%
The level of innovation activity of organizations	$Inov_{lvl_{it}}$	%
The share of organizations that implemented technological innovations in the total number of surveyed organizations	$Org_{tech_{it}}$	%
The share of innovative goods, works, and services in the total volume of shipped goods, completed works, and services	$Goods\_inov_{it}$	%
Socio-economic factors		
The number of arrivals from the Commonwealth of Independent States (CIS countries)	$Migr_{CIS_{it}}$	Number of people
The number of arrivals from foreign countries	$Migr_{foreign_{it}}$	Number of people

End of table 1

1	2	3
The number of registered crimes per 10 thousand people	$Crimes_{it}$	Pcs.
Investments in fixed assets in constant price (2017)	IFA_{it}	Mil. rubles
Number of higher education institutions per 10 thousand people	VO_{it}	Pcs.
Number of secondary vocational education institutions per 10 thousand people	SPO_{it}	Pcs.
The share of revenue from the sale of goods, products, works, and services in the mining industry	$shrmining_{it}$	%
The share of revenue from the sale of goods, products, works, and services in the manufacturing industry	$shrmnfact_{it}$	%
The share of revenue from the sale of goods, products, works, and services in the agricultural sector (including fishing)	$shragrclt_{it}$	%

Regression modeling was based on an approach that includes analysis of pooled data regression using the ordinary least squares method (OLS) and panel data models with fixed and random effects [36]. The calculations were carried out using the STATA 14 software product. To maintain linearity, for variables such as $NWage_{it}$, $Unempl_{it}$, $Left\_man_{it}$, $Goods\_inov_{it}$, $Migr_{CIS_{it}}$, $Migr_{foreign_{it}}$, IFA_{it} were used natural logarithms (ln).

Results. Table 2 shows the results of descriptive statistics of the selected variables. The average value for the $NWage_{it}$ variable is 39 066.362 and we noted the high standard deviation. The minimum value is 21 941 rubles, which was recorded in the Republic of Dagestan in 2017 and the maximum value was recorded in 2022 in the Chukotka Autonomous Area and amounted to 113 399.42 rubles. Chukotka Autonomous Area – is region specializes in mining: the share of revenue from the mining industry in economy is more than 54 %.

The level of unemployment rate is relatively low: the average value for the sample is 5.99 %, which roughly corresponds to the values in the European Union countries before the COVID [37], and which is lower than the average in developing countries for the corresponding period 2016–2017 [38]. It refers to a low value of the standard deviation, which indicates a stable value of the indicator both by year and by region. The minimum value is 1.2 %, and the maximum value of 30.9 % is fixed in 2021 in the Republic of Ingushetia, which is an outlier for the entire sample. This region can be characterized as a region with a low level of economic development, which is reflected in low GRP per capita [22].

Despite the fact that the reasons for the change of residence are subjective factors that correspond to the interests of a particular person [39], the authors also identify macrofactors: economic, social, demographic, political, and the external environment [40]. The average value of the number of departures of the population is 339.516 people per 10,000 population. The minimum value is 104.89 people per 10,000 population, which was recorded in the Chechen Republic in 2020. The maximum was recorded in 2022 in the Chukotka Autonomous Area. An analysis of the structure of the departed population shows that, on average, 84 % of all those who left move between regions, and not outside the country.

T a b l e 2. **Descriptive statistics of variables**

Variable	Mean	Std. Dev.	Min	Max
		Dependent variables		
NWage	39 066.362	17 391.724	21 941	113 399.42
Unempl	5.998	3.692	1.2	30.9
Left_man	339.516	130.801	104.89	1 174.33
		Independent variables		
Org_pk	87.395	8.086	48.679	100
Org_web	84.526	8.247	46.038	100
Exp_inov	1.572	1.562	0	9.603
Inov_lvl	10.499	5.58	0.179	33.759
Org_tech	18.794	7.692	0.6	47.285
Goods_inov	5.039	5.183	0	28.4
Migr_CIS	6 779.494	8 218.916	5	73 912
Migr foreign	766.324	944.337	0	6 046
Crimes	143.972	44.892	15.758	362.673
IFA	213 068.86	396 942.62	9 988	4 425 815.5
SPO	0.281	0.123	0.08	0.838
VO	0.043	0.021	0	0.128
shagrclt	0.046	0.047	0	0.324
shmining	0.123	0.192	0	0.806
shmnfact	0.256	0.147	0.003	0.655

Note. All calculations for compiling tables 2–4 and preparing graphs (fig. 1–3) were made in the Stata 14.2 program.

Table 3 shows the results of constructing a linear regression model (Model 1.1), a panel data model with fixed (Model 1.2) and random effects (Model 1.3). The adjusted coefficient of determination of the 1.1 model is 68 %. Testing the model revealed heteroskedasticity in the residuals, necessitating the use of robust estimates for the standard error of the model. The results of the tests for the heteroskedosticity of the residuals for the Model 1.1. are shown in Figure 1. The results of comparing models 1.2 and 1.3 using the Hausman test show that model 1.2 should be preferred. The adjusted coefficient of determination in model 1.2 is 45 %. The inverse relationship is observed in model 1.2 compared to model 1.1. between the *lnNWage* and *shrmnfact* and *SPO* variables.

Table 4 shows the results of a linear regression model (Model 2.1–2.2.), panel data models with fixed (Model 2.3) and random effects (Model 2.4). The *lnUnempl* variable is negatively correlated with the variables under study, except for the *lnCrimes* variable. The coefficient of determination in the model 2.1 is 47 %. When testing the model for the heteroskedosticity of residuals, we observed that the residuals were homogeneous (Fig. 2). When comparing panel data models, the Hausman test suggests that the fixed-effects model (Model 2.3) is the preferred option. However, the coefficient of determination for the 2.3 model is low, indicating a low level of explanatory power for the variables in this model.

Table 5 shows the results of a linear regression model (Model 3.1.–3.2.), panel data models with fixed effects (Model 3.3) and with random effects (Model 3.4). The adjusted coefficients of determination for the Models 3.1 are 49 %. Testing Model 3.1 for heteroscedasticity of residues shows the presence of homoscedasticity of residues (Fig. 3).

There is a significant positive relationship between the variable *lnLeft_man* and $lnLeft\_man_{t-1}$ in model 3.2. The Hausman test shows that a fixed-effects model should be preferred (Model 3.3). The adjusted coefficient of determination in this model is 32 %.

T a b l e 3. **Results of regression analysis for dependent variable *lnNWage***

Variables	Model 1.1	Model 1.2	Model 1.3
lnIFA	0.202***	0.068***	0.087***
shmnfact	–0.218**	0.279***	0.176**
Inov_lvl	–0.015***	–0.008***	–0.009***
Org_tech	0.018***	0.005***	0.006***
lnGoods_inov	–0.031***	–0.007*	–0.007
shmining	0.598***	0.203**	0.592***
lnMigr_foreign	–0.032***	0.003	0.000
lnCrimes	0.143***	–0.025	0.069*
SPO	0.869***	–1.261***	–0.527***
shagrclt	1.186***	0.895***	0.833***
_cons	7.177***	10.019***	9.130***

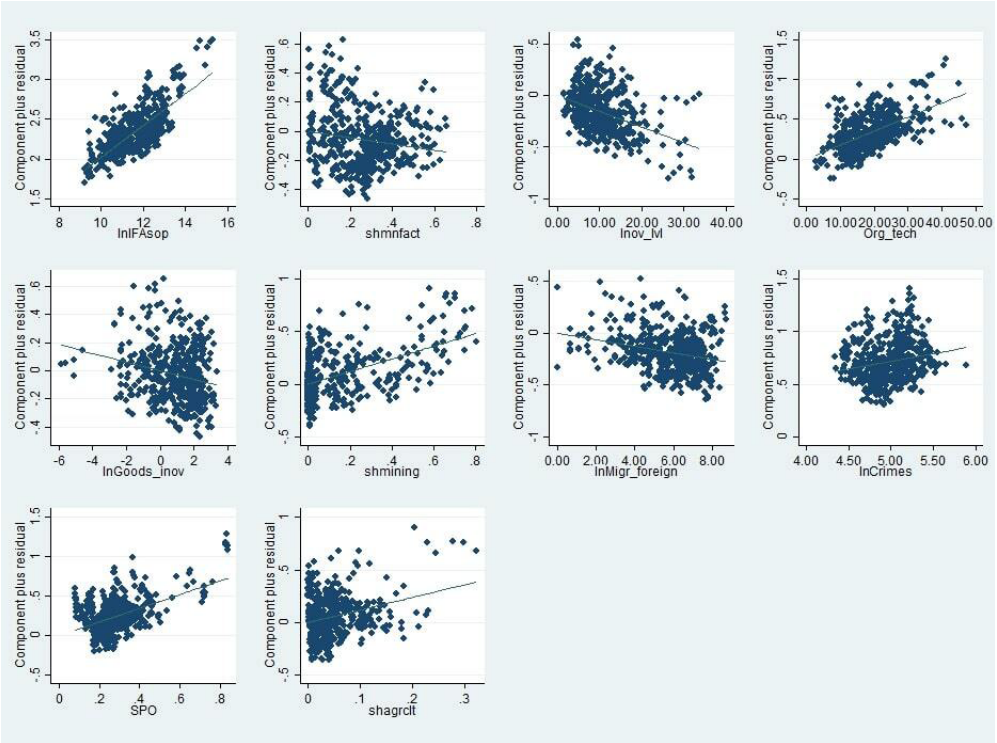
Note. From here on in the article $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

T a b l e 4. **Results of regression analysis for dependent variable *lnUnempl***

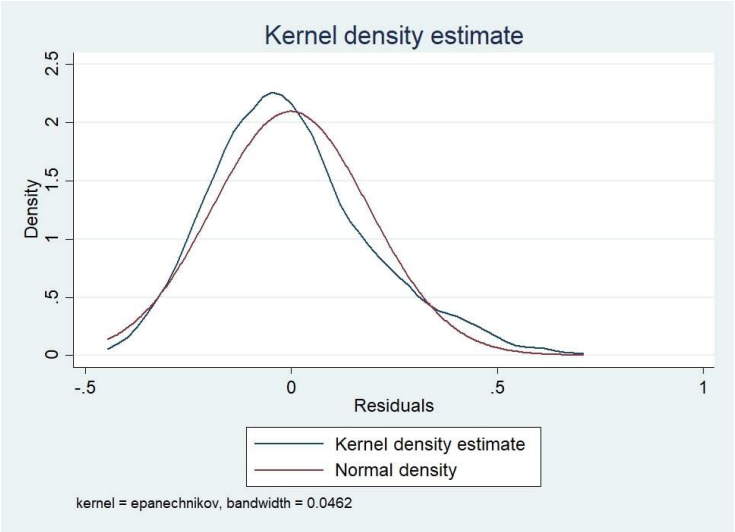
Variables	Model 2.1	Model 2.2	Model 2.3	Model 2.4
lnIFA	–0.143***	–0.145***	–0.148***	–0.153***
shagrclt	–1.250***	–0.710	–0.873	–1.202*
shmnfact	–0.409***	–0.304*	–0.569*	–0.802***
Org_tech	–0.013***	–0.005**	–0.001	–0.005*
shmining	–0.392***	–0.189	–0.940***	–0.783***
lnMigr_CIS	–0.084***	–0.042*	–0.029	–0.057***
SPO	–0.618***	–0.274	1.271**	0.187
lnCrimes	0.237***	0.177*	0.359**	0.052
$lnUnempl_{t-1}$		0.655***		
_cons	3.435***	3.099***	1.822*	4.060***

T a b l e 5. **Results of regression analysis for dependent variable *lnLeft_man***

Variables	Model 3.1	Model 3.2	Model 3.3	Model 3.4
VO	–2.726***	–3.294**	–1.094	–1.876
Org_web	0.009***	0.008***	0.007***	0.008***
lnIFA	–0.064***	–0.020	–0.019	–0.023
shmnfact	–0.336***	–0.523***	–0.374**	–0.283*
shmining	0.270**	–0.190	–0.221	0.081
SPO	0.696***	0.771***	0.758**	0.941***
lnMigr_CIS	0.076***	0.012	0.025	0.040**
lnMigr_foreign	–0.038**	–0.006	–0.010	–0.018*
lnCrimes	0.196***	0.073	–0.049	0.162**
shagrclt		–1.086***	–1.527***	–0.959**
$lnLeft\_man_{t-1}$		0.481***		
_cons	4.384***	5.084***	5.520***	4.282***

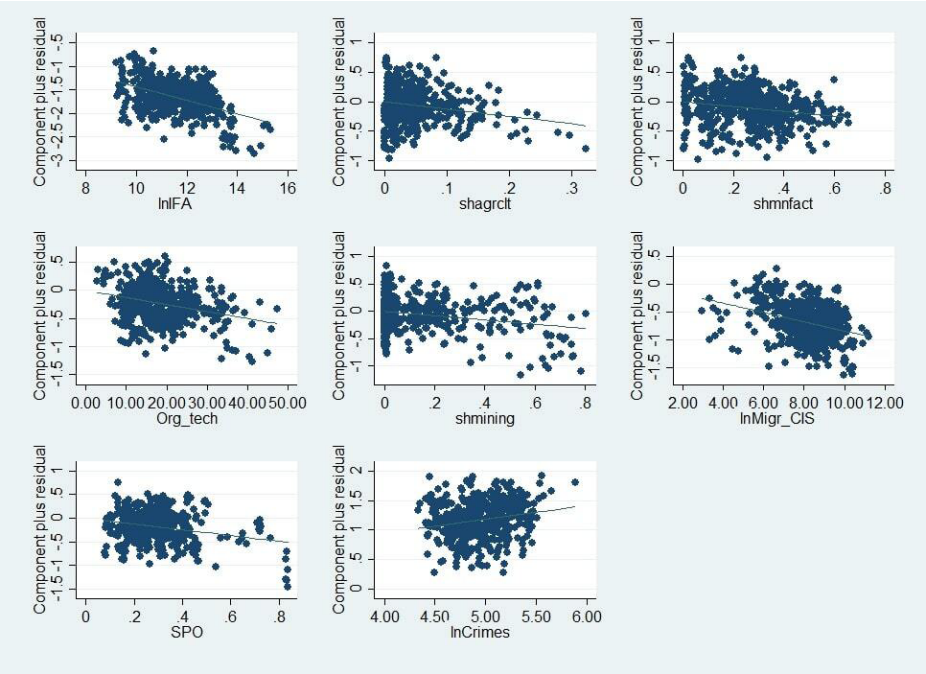


(a)



(b)

F i g. 1. (a) Matrix of partial residual graphs and (b) Graphic tests for normal distribution of the residuals of the model 1.1



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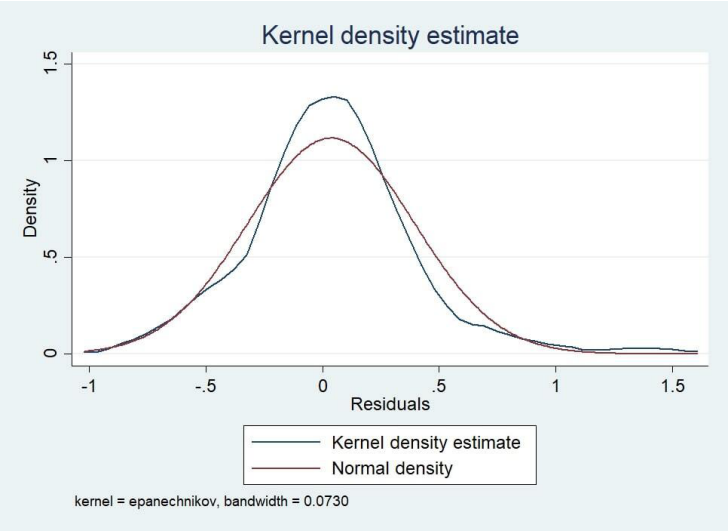
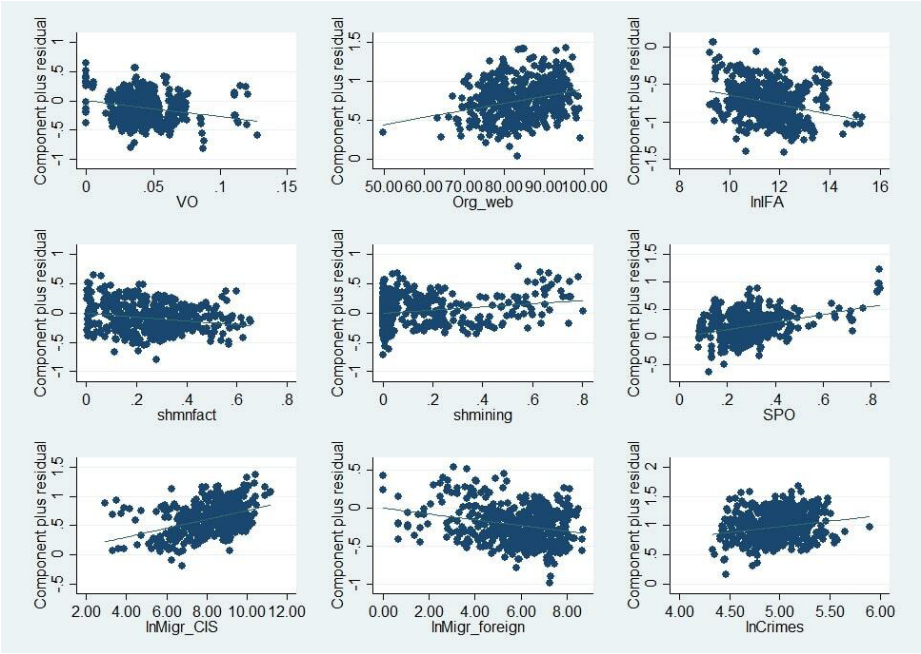
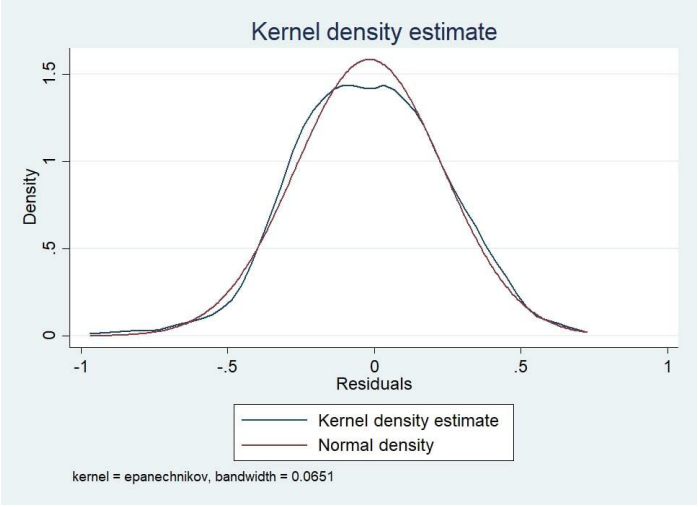


(b)

F i g. 2. (a) Matrix of partial residual graphs and (b) Graphic tests for normal distribution of the residuals of the model 2.1



(a)



(b)

F i g. 3. (a) Matrix of partial residual graphs and (b) Graphic tests for normal distribution of the residuals of the model 3.1.

Discussion and Conclusion. The obtained results allow us to conclude the following. Investments in fixed assets are one of the factors of economic growth [23], and in turn, economic growth is positively associated with the standard of living. Models 1.1. and 1.2. confirm that in regions where large investments in fixed assets are made, wages are higher. Paper [22] shows that investments in fixed assets in Russia are associated

with the specialization of regions in the extractive industry. This relationship is reflected in our study.

The positive influence of the agricultural industry with wages may be due to the technological development of agricultural enterprises in recent years in connection with the implementation of Federal Scientific and Technical Program for the Development of Agriculture[7]. Investments in new technologies create new requirements for the level of knowledge and qualifications of labor. As a result, wage growth and stimulates the growth of investments in the continuation of the mechanization of the industry[8].

In general, we observed that the organizations implementing technological innovations is positively related to wages [30]. This situation may also be related to the significant role of innovation in the extractive industry [41], where the average wage level is higher than in regions of Russia that do not specialize in mining [42]. At the same time, we observed a negative relationship between the *lnNWage* indicator and the level of innovation activity of organizations and the share of innovative goods, works, and services in the total volume of shipped goods, completed works, and services. As in the study by Mlinarević P., Balotić G. and Paunović S.[9], our hypothesis about the impact of innovation on wage growth was not confirmed. Considering the results obtained, and taking into account that all three indicators reflect technological development, we cannot make a definitive conclusion about the relationship between technology and wages.

The results of models 2.1.–2.4. show that technological and socio-economic development of territories are negatively correlated with unemployment. Thus, we observe that the development of the productive sectors of the economy and the growth of investments in fixed assets create employment opportunities and reduce the unemployment rate [24; 25].

It was also revealed that the proportion of organizations engaged in technological innovations is negatively associated with unemployment. We could argue that these results connect with the hypothesis of the positive impact of innovation on employment [31]. Nonetheless, other factors of digital and technological development turned out to be insignificant. Therefore, as in the work [34], we cannot accurately suggest about the positive or negative impact of innovation development on employment at the macro level. But unlike [34], we see a significant positive relationship between unemployment and the lag value of unemployment ($lnUnempli_{t-1}$). In regions with high unemployment, its growth is observed in the following periods, which indicates the long-term effects of unemployment.

The positive relationship between unemployment and number of crimes, as identified in models 2.1, 2.2, and 2.3, confirmed our hypothesis and correspond with research

[7] Kuzmin V. N., Korolkova A. P., Marinchenko T. E. Mechanism for increasing innovative activity in agriculture in Russia using programming // IOP Conference Series: Earth and Environmental Science. 2021. https://doi.org/10.1088/1755-1315/723/3/032055

[8] Yamauchi F. Wage Growth, Landholding, and Mechanization in Agriculture: Evidence from Indonesia // World Bank Policy Research Working Paper No. 6789. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2404639 (accessed 25.10.2024).

[9] Mlinarević P., Balotić G., Paunović S. The impact of innovation on the growth of real wages in the western Balkan countries // 3rd International Conference "Economic and Business Trends Shaping the Future" / Faculty of Economics-Skopje, Ss. Cyril and Methodius University in Skopje. 2022. Pp. 278–287. http://doi.org/10.47063/EBTSF.2022.0024

findings[10] [35]. These results confirm the importance of social support for citizens, especially in unstable periods of economic recession.

We observed that the number of departures of the population is negatively corelated to factors of investment, industrial development, accessibility of higher education and the number of migrant people from foreign countries. We can assume that regions with high standards and quality of life become centers of attraction, not only for their own local populations, but also for people from other countries. As the study shows [43], migration models for specialists are different for different regions and Federal Districts of Russia. We see that in regions with a high number of departures of the population in the previous period ($lnLeft\_mani_{t-1}$) the outflow of population is higher in the current period. Models 3.1.–3.3. show that the reasons for departure are also the level of criminality, the number of migrants from CIS countries, as well as the share of the extractive industry in the economy. We can assume that the outflow of population from regions specializing in mining is associated with the remoteness of such regions from the federal center (Siberia, the Far East), as well as the current need for economic development of the regions [44].

We also received uncertain results on the impact of the accessibility factor of education. As opposed to [28] we did not see evidence in the models that the availability of higher education affects wages and unemployment. However, we saw the relationship between secondary vocational education organizations and wages and unemployment. According to models 3.1–3.4 the availability of higher education in the region is a factor in ensuring that people do not leave the region. And we see the opposite situation with the availability of secondary vocational education: the presence of secondary vocational education in regions is positively correlated with the number of departures population from the region. This can be explained by the specifics of the development of the education system in Russia. According to descriptive statistics in Table 2 there are 6.5 times more secondary vocational education institutions per 10,000 people than universities. Due to educational system reforms in 2012 and closures of inefficient universities, the regions faced youth migration. Students who want to get higher education are forced to move to medium and large cities [45]. These changes have clearly impacted the socio-economic development of small towns and regions without higher education facilities.

We observe a negative relationship between the availability of secondary vocational education and wages (model 1.2). The problems of employers' dissatisfaction with the quality of training of workers was described by A. A. Stepanov [46]. However, we suggest that these identified relationships require further investigation, because it may be linked to the nature of manufacturing development in the country.

Thus, the hypotheses H1, H3 and H6 were confirmed, and H2, H4 were confirmed partly. We have not seen evidence of the impact of access to higher education on wages and unemployment and cannot be certain about the relationship between number of crimes, manufacturing industry and wages, because the models show contradictory results. We also cannot suggest that technological innovations really affect the elements of personnel security (H5). In general, the results show that the variables of personnel security are mainly influenced by socio-economic factors.

[10] Wang X., Shixin Hu. Analysis of the relationship between unemployment and crime rate in China // Proceedings of the 2021 International Conference on Social Development and Media Communication (SDMC 2021). 2022, Atlantis Press. Pp. 665–670. https://doi.org/10.2991/assehr.k.220105.122

The authors have explored various relationships, each of which could be the subject of a separate study. It will be important to study more closely the identified relationships between the components of personnel security by collecting more statistical data and using other modeling techniques to evaluate long-term effects. In our opinion, gravity modeling and the construction of ARDL (Autoregressive Distributed Lag) panel data models are two promising approaches for this purpose. Nevertheless, the results obtained reflect the importance of interaction between executive authorities making decisions in various sectors of the economy. For example, investment policy decisions can significantly affect the unemployment rate in the region, and the development of innovations affects the standard of living of citizens. The results can be used as a scientific justification for the need to improve the socio-economic, innovative, industrial, investment, personnel, and other policies of the region in order to increase personnel security, and, as a result, achieve a high quality and standard of life and sustainable development.

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