

Statistical analysis of the impact of innovations on labour productivity in the constituent entities of the Central Federal District

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ORIGINAL ARTICLE

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Abstract. The relevance of the research topic is due to the contradiction between the innovation activity of organisations and their contribution to regional socio-economic development. Innovation should lead to productivity growth and contribute to the creation of high-productivity jobs. However, the situation in many Russian regions is paradoxical one – despite of high innovation activity of small and medium-sized enterprises their labour productivity remains at the same level or decreases. The purpose of the research is to assess the impact of innovations on labour productivity for the Russian economy on the example of the Central Federal District regions. The paper verifies the hypothesis on the presence of statistically significant relationship between the indicators characterising the innovation activity of small and medium-sized enterprises, the index of labour productivity, and the growth of high-productive jobs in the Central Federal District regions through the methods of economic and mathematical modelling. According to the research results, the parameters of small and medium-sized enterprises innovation activity do not have a significant impact on the dynamics of socio-economic development of the Central Federal District regions.

Keywords: innovation activity; labour productivity; CFD, SMEs; innovation; correlation analysis

JEL codes: R11, O32

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Introduction

From an economic perspective, innovations act as a key factor of regional development. They contribute to the growth of labour productivity, increase GRP, and, finally, ensure the improvement of the population quality of life.

Innovations are becoming even more important in the context of unprecedented sanctions against the Russian economy. Labour productivity growth and the creation of highly productive jobs are long-term drivers of economic growth. These drivers will make it possible to reduce the negative effects of economic sanctions against the Russian economy and solve the problem of labour shortages developed in recent years. However, there is a paradoxical situation in many constituent entities of the Russian Federation: high innovation activity of small and medium-sized enterprises (SMEs) has practically no impact on labour productivity and other macroeconomic indicators of regional development.

The relationship between innovation and labour productivity is revealed in modern economic research:

Kurt S. & Kurt Ü. (2015): Although it is generally accepted that innovation increases the efficiency and productivity of capital, it can also be said that it increases the productivity of labour force as well. Recently the ease and prevalence of performing research through the internet, as well as developments in information and communication technologies had a positive effect on load and productivity of labour force accelerated workflow and also increased the efficiency of production processes and output amounts. Developments of information and communication technologies especially provided development opportunities for countries having high population and labour force and also a high development potential due to an increase in efficiency and productivity of labour force and helped them to have faster and easier economic growth or development. In this study, the aim is to research the effects of innovation on labour productivity for the 5 countries defined as BRICS (Brazil, Russia, India, China, South Africa) which have drawn attention in recent years due to their economic performances by using panel data and dynamic panel data methods. The results of the study produced a positive relationship between innovation and labour productivity [1].

Preenen P.T.Y., Vergeer R., Kraan K. & Dhondt S. (2017): Findings suggest that internal labour flexibility practices benefit both labour productivity and innovation performance of companies. If innovation and labour productivity are considered key to long-term survival, firms and policymakers should consider internal labour flexibility practices [2].

Ismail R. (2018): Human capital theory postulates that investment in human capital will increase labour quality and eventually generates higher productivity in an organisation. In small and medium enterprises (SMEs), the quality of workers is still low due to lack of investment in human capital especially in terms of training; and this is the main cause of low labour productivity, hence, leading to weak firm's performance. This article aims to analyse the impact of human capital and innovation on labour productivity by utilising the data of 4,661 manufacturing firms of 2009 in Malaysia. The result shows that human capital and innovation play significant roles in increasing labour productivity in Malaysian SMEs [3].

Okumu I.M. & Buyinza F. (2018): Our results indicate that the relationship between labour productivity and a firm engaging in any form of innovation is neutral. However, there is evidence of complementarity among product, process, marketing and organisational innovation. Specifically, there is a positive association between labour productivity and innovation when a firm engages in all the four innovation types. Even then, the complementarity effect turns out weakly positive with incidences of negative relationship when using any combination of innovations that are less than the four types of innovations [4].

Kheyfets B.A. & Chernova V.Y. (2019): The article examines the dependence of the growth rates of labor productivity on the growth rates of investments in fixed assets in Russian agriculture. The situation in Russian agriculture shows that in recent years, against the background of significant investments in fixed assets and growth of physical capital, the quality of this capital remained at a low level and could not ensure high and long-term growth in labor productivity. Additionally, an assessment of the intensity of innovation activity was conducted and an analysis of the factors was made, hindering the spread and introduction of breakthrough digital technologies [5].

Bhattacharya P. & Rath B.N. (2020): By employing simple ordinary least squares (OLS) regression technique, we find that innovation affects the labour productivity positively for Chinese as well as Indian manufacturing firms, but its impact on firm productivity is relatively weak in case of India as compared to China. Second, other factors such as average wage of the workers, education of production workers and training do significantly boost the labour productivity of Chinese manufacturing firms as well as for Indian firms. Third, our results based on firm size also indicate that the impact of innovation activities on labour productivity is higher in case of large firms as compared to medium firms. However, innovation does not affect the labour productivity of small manufacturing firms for both China and India [6].

Woltjer G., van Galen M. & Logatcheva K. (2021): The results show that both product and process innovation increase labour productivity and therefore induce direct reductions in employment. However, these negative employment effects are more than compensated by increases in sales, implying that both process and product innovations increase employment. It is argued that the effects for sales and labour productivity are probably underestimated in all research that uses CIS survey data because these do not show the price

effects of increased productivity, but that this effect cancels out in the estimated employment equation [7].

Wadho W. & Chaudhry A. (2022): We find significant heterogeneity in the impact of different innovations on labor productivity: Organizational innovation has the largest effect followed by process innovation. But unlike much of the literature, we found a negative impact of product innovation suggesting a disruption effect of new products. We find a strong impact of engaging in knowledge creation on product and process innovation. We also find that external knowledge networks and innovation cooperation play no significant role in firms' decision to engage in innovation and its intensity, however, vertical linkages with suppliers (clients) promote product (process) innovations. Foreign competition has a negative effect on product innovation and a positive effect on organizational innovation. Exposure to foreign markets both in term of exporting and quality standard certification leads to better innovation performance [8].

García J.F., Armenta A., Martínez L., Rebollo J. & Rentería R. (2023): The existence of a relative but not determinant influence of the innovation in the labor productivity of the Mexican manufacturing industry was found, since the gross formation of fixed capital contributes more to it, and that the decreasing tendency of its levels of labor productivity is a reflection of structural failures and obsolescence in the productive apparatus, so that innovation represents a change in the technological trajectory for Mexican manufacturing activities, providing higher levels of labor productivity and competitiveness [9].

Naveed A. & Wang C. (2023): This paper attempts to explain the impact of innovation on productivity, which is moderated by structural change. Ignoring such a moderation effect may cause over- or underestimation of the true effect. Using a global sample from 1996 to 2013 for a panel of 65-87 countries with treatments for endogeneity (2SLS and system GMM), we find a positive significant effect of innovation on both structural change weighted productivity and unweighted average productivity, and that the effect on structural change weighted productivity is larger. We also find this effect to differ in economies experiencing different structural transition phases and income levels. Our results are robust across alternative measures of structural change, such as diversity measure and natural resource share in GDP [10].

Tetteh C.K. (2024): The results highlight the multifaceted determinants of labour productivity in Ghana's manufacturing sector, emphasizing the positive impact of R&D. R&D also significantly influence both product and process innovation. These findings are useful for the development of human capital in Ghana [11].

The analysis of the sources allows us to conclude:

- studies of the innovations' impact on labour productivity have a well-defined country specificity;
- innovation generally has a positive impact on labour productivity growth both at the organisation and the national economy levels.

The purpose of the research is to assess the impact of innovations on labour productivity for the Russian economy on the example of the Central Federal District regions.

Methods

According to the hypothesis of the study, there is a direct, statistically significant relationship between the level of innovation activity of SMEs and the dynamics of socio-economic development of the CFD regions. Innovation contributes to the growth of labour productivity, and provides a creation of highly productive jobs.

To assess the innovation activity of SMEs in Russia, we use Rosstat data and methodological recommendations for assessing the level of innovation activity at the regional stage: «The level of innovation activity of organisations» (approved by the Federal State Statistics Service (Rosstat) by order No. 818 on 27 December 2019)¹. The methodology was developed to ensure the formation of official statistical information on the indicator «Level of innovation activity of organisations». The methodology is also used to ensure comparability with the indicator «The share of organisations engaged in technological innovation in the total number of examined organisations». This indicator is developed for the purpose of information support for monitoring the achievement of the national goal «Acceleration of technological development of the Russian Federation, increasing the number of organisations implementing technological innovations to 50 percent of

¹ Order No. 818 on 27.12.2019 «On approval of the methodology for calculating the indicator «Level of innovation activity of the organisation». Available at: URL: <https://rosstat.gov.ru/storage/mediabank/pr818-27122019.pdf> (accessed: 01.05.2024) (in Russian).

their total number», defined by the Decree of the President of the Russian Federation No. 204 on 7 May 2018².

Methodological basis of the research:

1. The research period is 13 years (long-term).

2. The indicators under study: the level of innovation activity of organisations (LIAO); the share of organisations implementing technological innovations (SOITI); the volume of innovative goods, works, services (VIGWS); the cost of innovation activity of organisations (CIAO); the share of small enterprises implementing technological innovations in the reporting year in the total number of surveyed small enterprises (SSEITI)³; the labour productivity index (LPI); the growth of high-productive jobs (GHPJ).

3. Sample: regions of the Central Federal District, 2010-2023.

4. Research methods: correlation analysis is used to test the proposed hypothesis. In this research, a significance level (p-value) of 5% was used to test the significance of the correlation coefficient.

The dynamics of the studied indicators in the long-term time interval is presented on Figures 1-7.

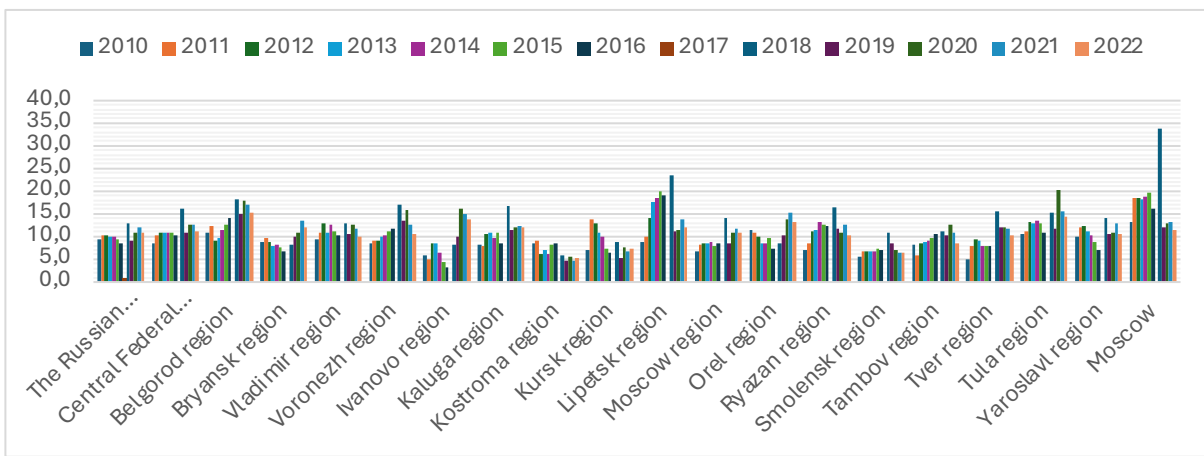


Figure 1. Level of innovation activity of organisations, by constituent entities of the Russian Federation, 2010-2022

Source: composed by the authors according to Rosstat data

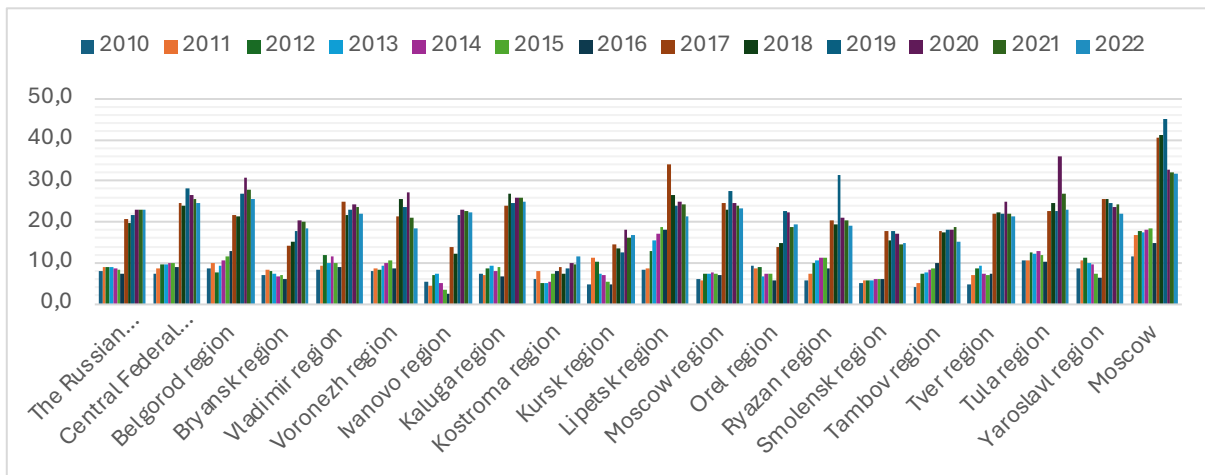


Figure 2. Share of organisations implementing technological innovations in the total number of examined organisations, by constituent entities of the Russian Federation, 2010-2022

Source: composed by the authors according to Rosstat data

² Decree of the President of the Russian Federation on 07.05.2018 No. 204 «On national goals and strategic objectives of the development of the Russian Federation for the period until 2024». Available at: URL: <http://publication.pravo.gov.ru/Document/View/0001201805070038> (accessed: 01.05.2024) (in Russian).

³ The data according to Rosstat. Section: Science, Innovation and Technology. Available at: URL: <https://rosstat.gov.ru/statistics/science> (accessed: 01.05.2024) (in Russian).

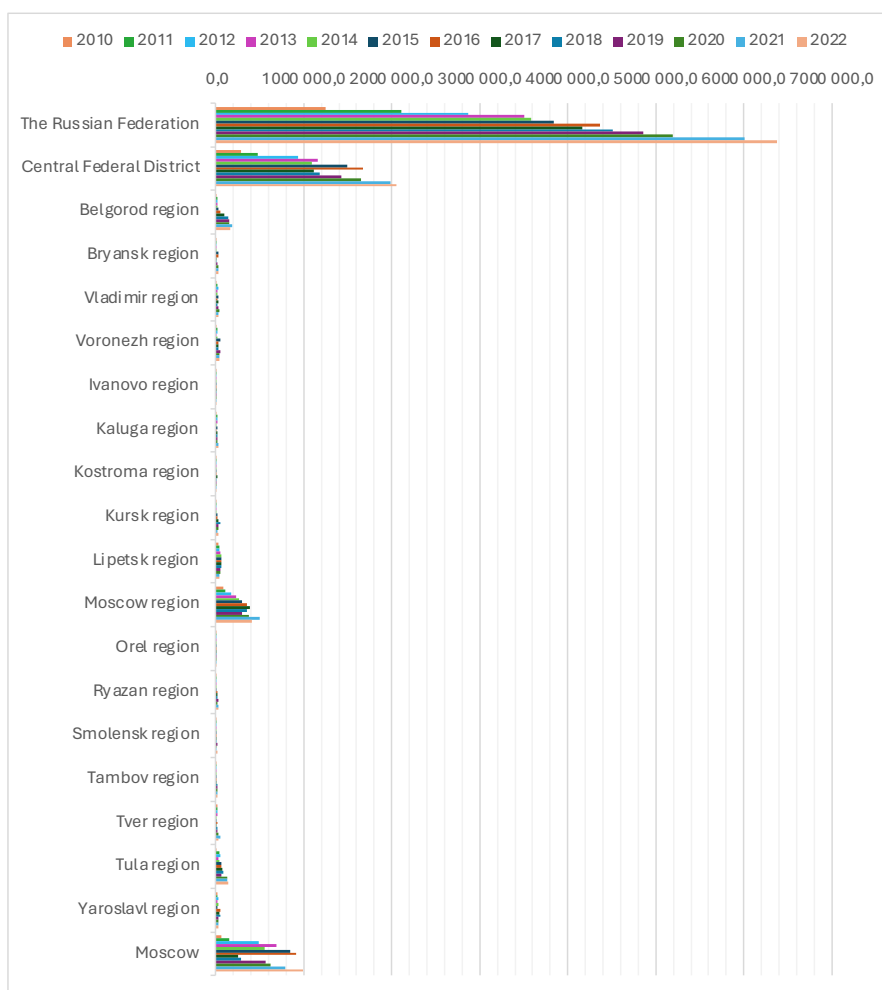


Figure 3. Volume of innovative goods, works, services, by constituent entities of the Russian Federation, 2010-2022

Source: composed by the authors according to Rosstat data

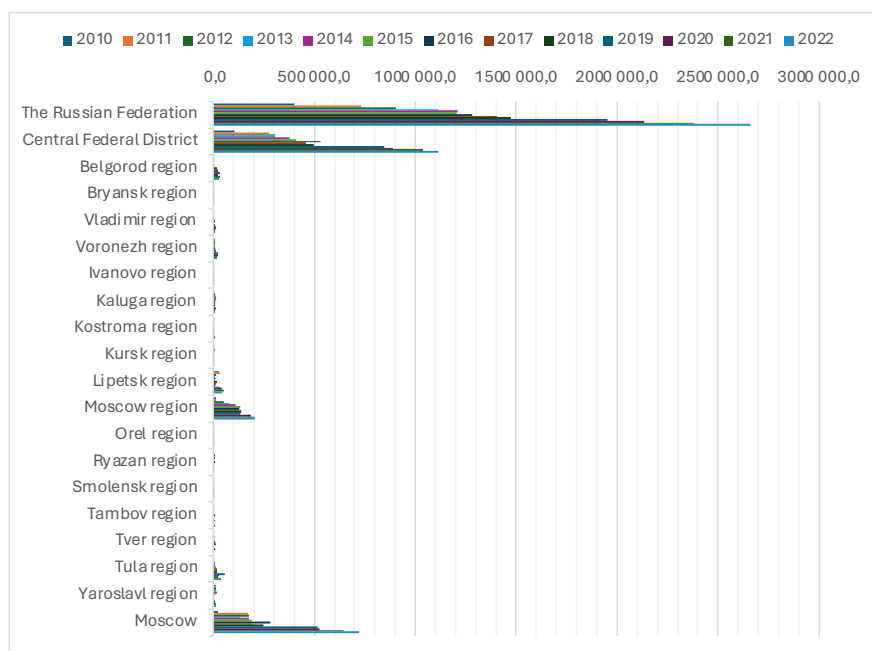


Figure 4. Costs of innovation activities of organisations, by constituent entities of the Russian Federation, 2010-2022

Source: composed by the authors according to Rosstat data

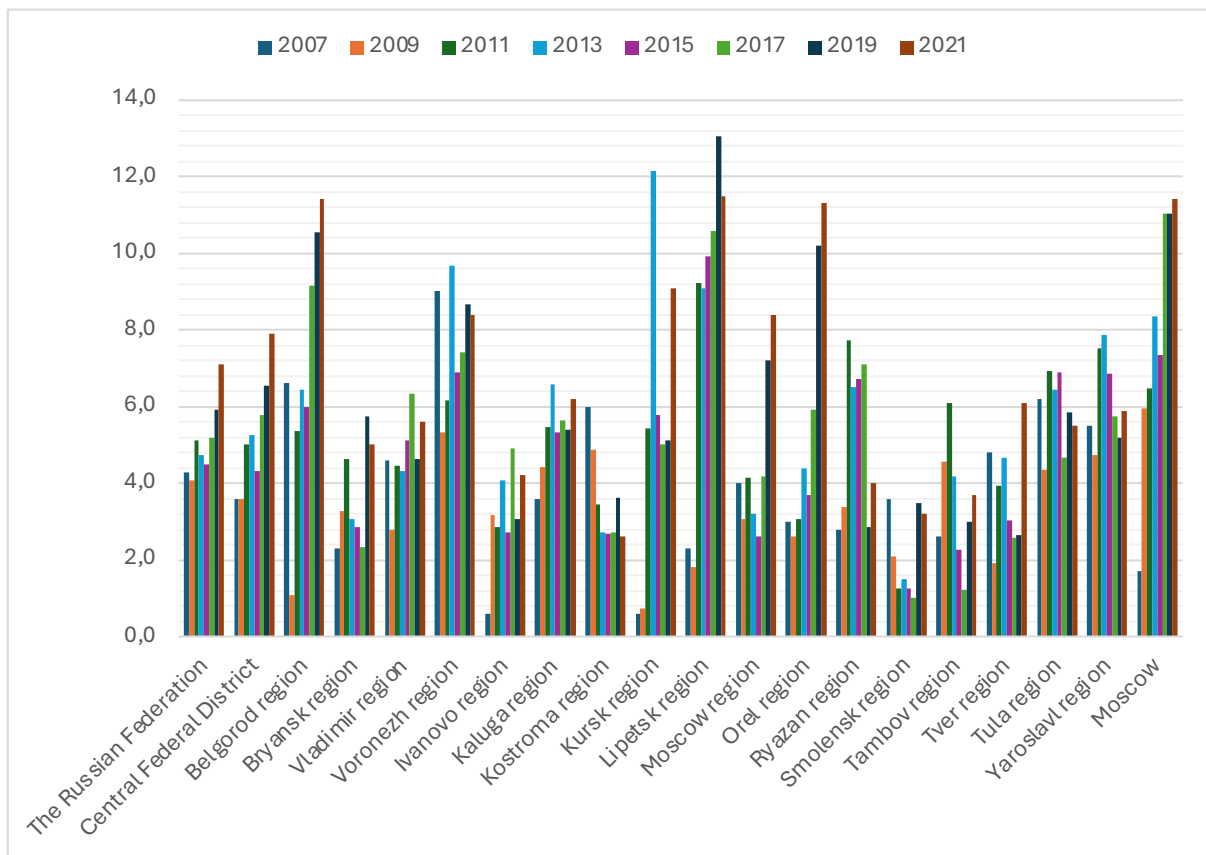


Figure 5. The share of small enterprises implementing technological innovations in the reporting year in the total number of examined small enterprises, by constituent entities of the Russian Federation, 2007-2021
 Source: composed by the authors according to Rosstat data

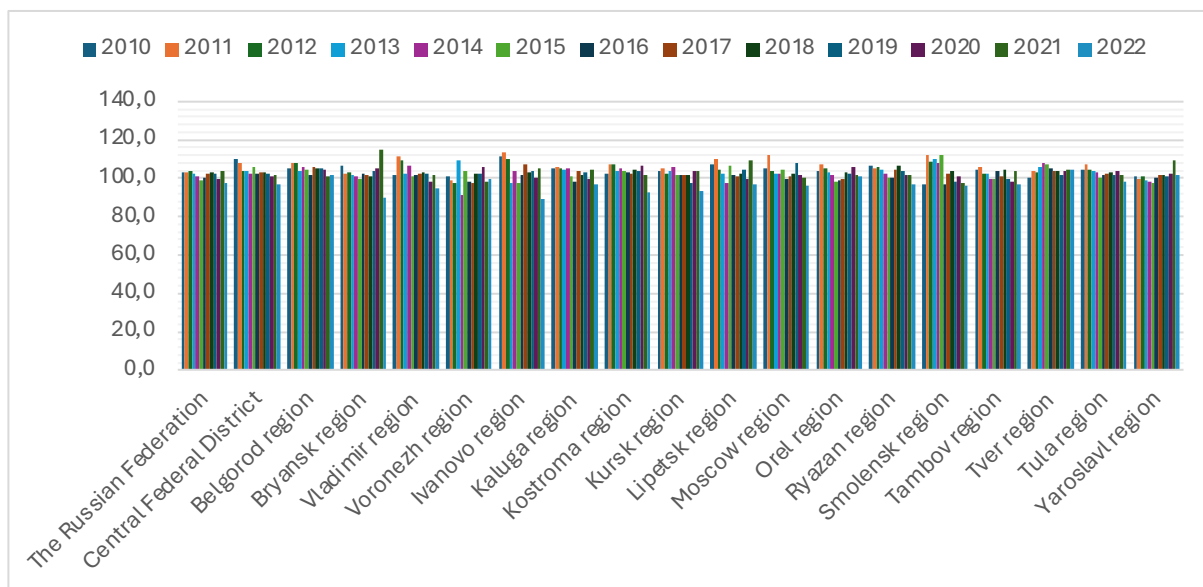


Figure 6. Dynamics of the labour productivity index (in % to the previous year) in the CFD regions, 2010-2022

Source: composed by the authors according to Rosstat data⁴

⁴ The data are given according to Rosstat. Section: Efficiency of the Russian economy. Available at: URL: <https://rosstat.gov.ru/folder/11186> (accessed: 01.05.2024) (in Russian).

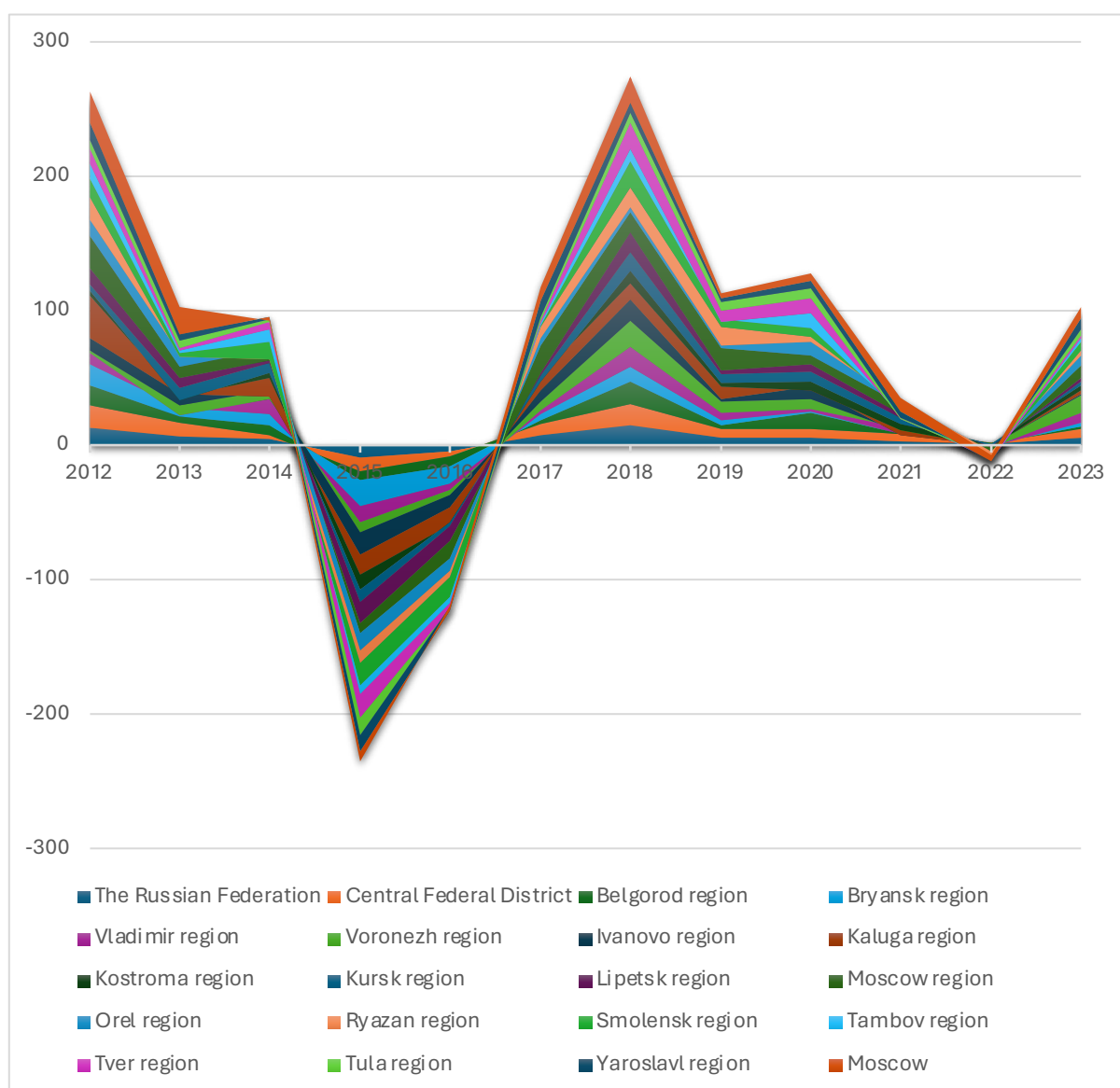


Figure 7. Dynamics of growth of high-productive jobs (in % of the previous year) in the regions of the Central Federal District, 2012-2023

Source: composed by the authors according to Rosstat data⁵

Results

Figures 8-9 (visual interpretation) and Table 1 (analytical interpretation) present the results of the correlation analysis.

Table 1 – Results of correlation analysis

p-val	power	Parameter pairs	Interpretation of the relationship	Significance of the relationship	Correlation between indicators
0.147533	0.30548	LIAO vs LPI	Not relevant		
0.000531	0.936499	LIAO vs GHPJ	Weak	Significant	Direct
0.00255	0.857651	SOITI vs LPI	Very weak	Significant	Inverse
6.47E-05	0.9806	SOITI vs GHPJ	Weak	Significant	Direct

⁵ The data are given according to Rosstat. Section: Efficiency of the Russian economy. Available at: URL: <https://rosstat.gov.ru/folder/11186> (accessed: 01.05.2024) (in Russian).

p-val	power	Parameter pairs	Interpretation of the relationship	Significance of the relationship	Correlation between indicators
0.149741	0.302734	VIGWS vs LPI		Not relevant	
0.08915	0.398886	VIGWS vs GHPJ		Not relevant	
0.499684	0.103632	CIAO vs LPI		Not relevant	
0.115315	0.351325	CIAO vs GHPJ		Not relevant	
0.433652	0.122789	SSEITI vs LPI		Not relevant	
0.027942	0.599699	SSEITI vs GHPJ	Weak	Significant	Direct

Source: composed by the authors

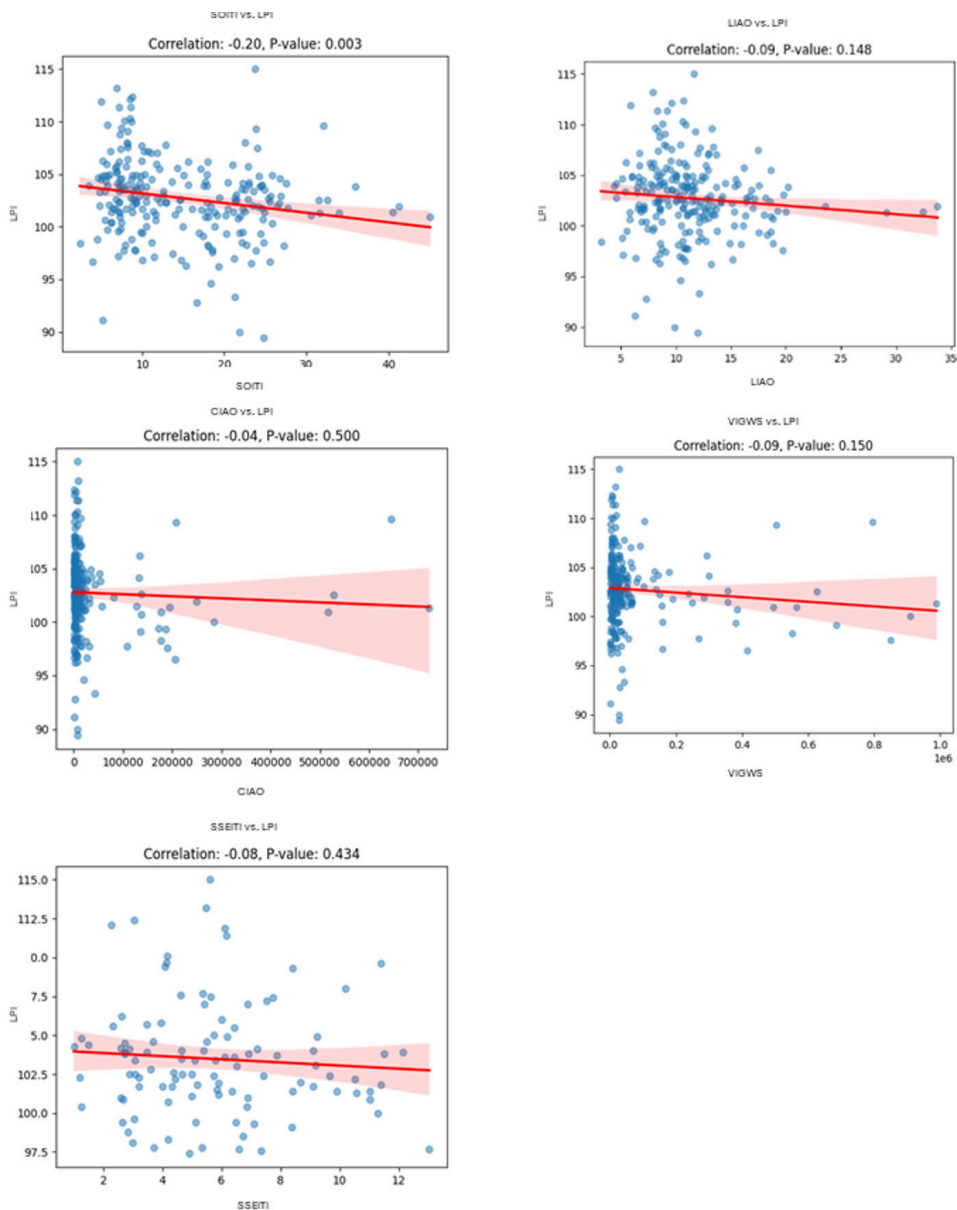


Figure 8. Scatter diagram between the indicators under study

Source: composed by the authors

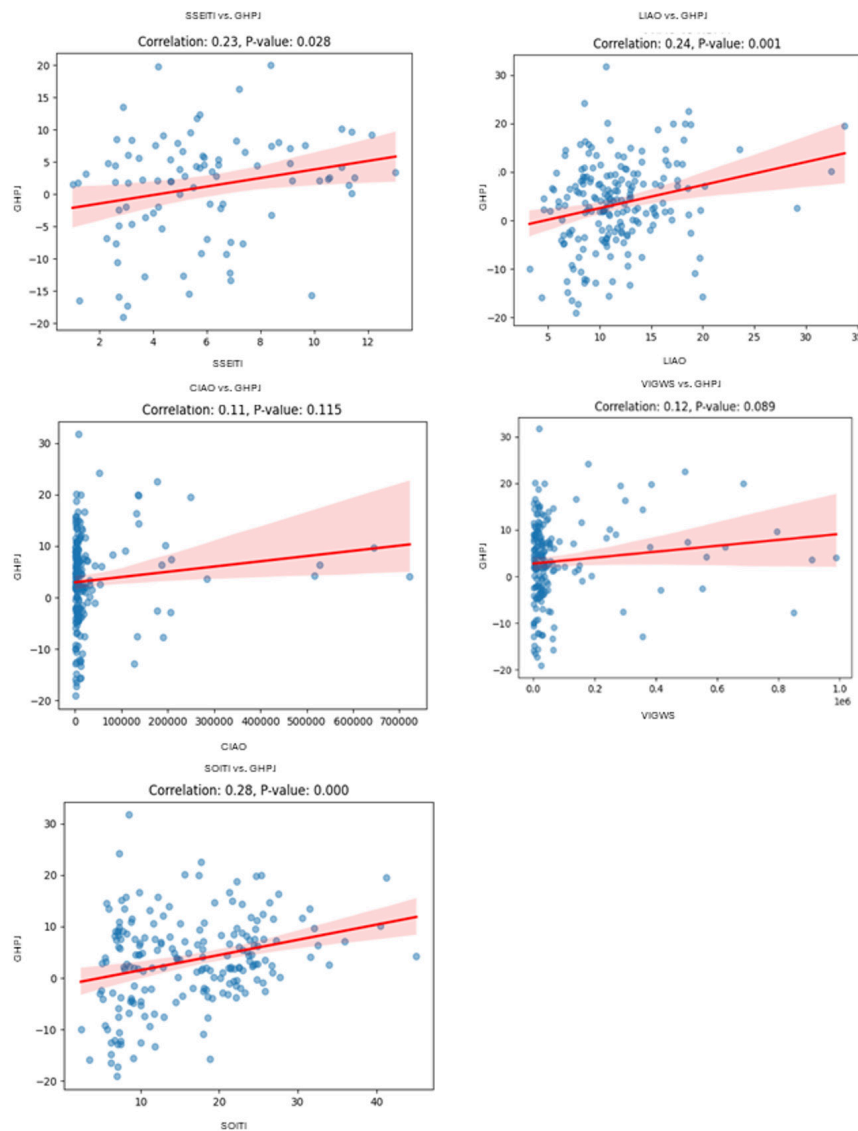


Figure 9. Scatter diagram between the indicators under study

Source: compiled by the authors

According to the research results, the parameters of SME innovation activity do not have a significant impact on the dynamics of socio-economic development of the CFD regions.

Conclusion

As a result of the research conducted, we found the following:

- there is a weak statistically significant direct relationship between the level of innovation activity of organisations and the growth of high-productive jobs in the CFD regions;
- there is a very weak statistically significant inverse relationship between the share of organisations implementing technological innovations and the labour productivity index in the CFD regions;
- there is a weak statistically significant direct relationship between the level of innovation activity of organisations and the growth of high-productive jobs in the CFD regions;
- there is a weak statistically significant direct relationship between the share of small enterprises implementing technological innovations and the growth of high-productive jobs in the CFD regions.

In general, the results obtained contradict earlier studies [1-11] and do not support the proposed research hypothesis.

The obtained (negative) results can be explained by the low level of knowledge-intensive products in the total GRP structure of the analysed regions; the small importance of SMEs for the Russian economy (compared to developed countries)⁶.

Research limitations:

- data discontinuity skewing the overall picture by the impact of the coronavirus pandemic and subsequent lockdown in 2020 and 2021;

- external shocks that have a significant impact on the dynamics of socio-economic development of the CFD regions;

- perhaps, the use of correlation analysis for solving the research objective was not optimal one (the research methodology is being tested and searched).

We believe, the data obtained will activate a new wave of applied research on the impact of innovation on regional economic development dynamics.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

Marina A. Mayorova – conceptualization, project administration, writing – original draft.

Maksim I. Markin – formal analysis; visualization.

Alexander Y. Zaytsev – data curation, investigation.

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